

2006 ENGINE

Engine Mechanical - 4.6L (5 Of 5) - Lucerne

VALVE LIFTER INSTALLATION - RIGHT SIDE

TOOLS REQUIRED

J 39946 Crankshaft Socket - 4. See **Special Tools** 4.6L

INSTALLATION PROCEDURE

1. Ensure the crankshaft is in the TDC position for the number one cylinder using the **J 39946** . See **Special Tools** .

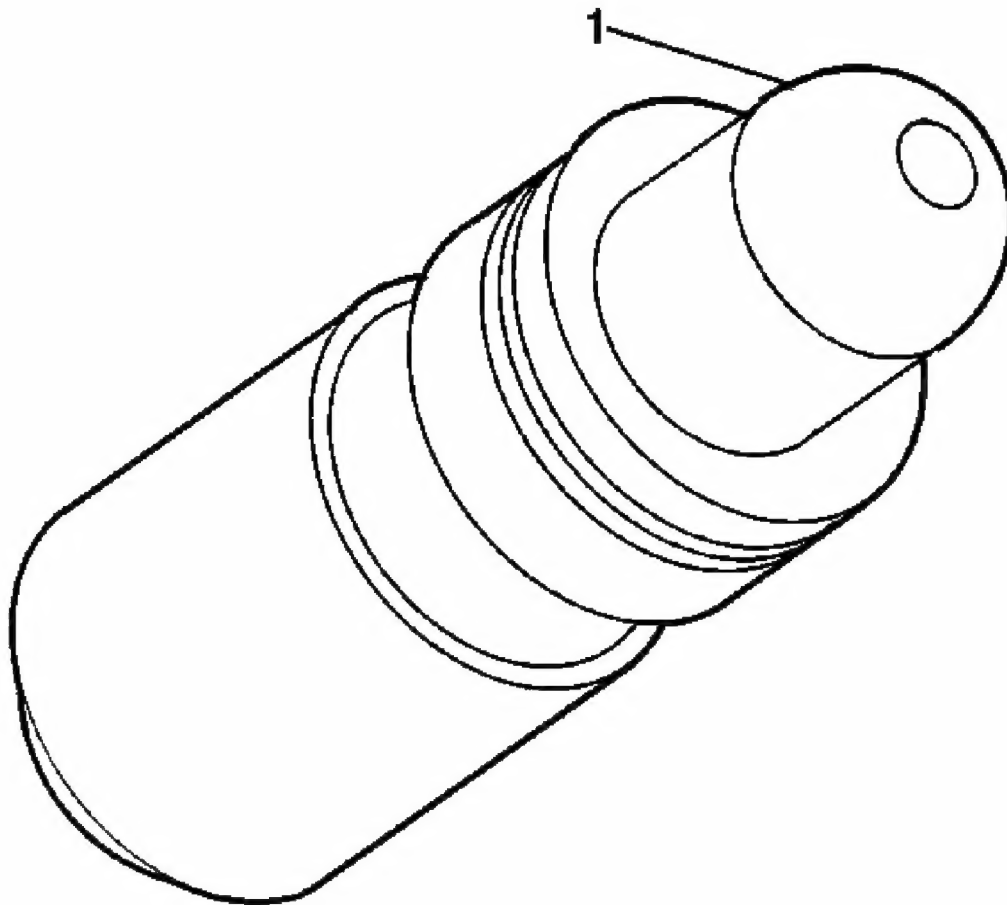


Fig. 1: View Of Valve Lifter
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to VALVE LIFTER PRIMING NOTICE .

2. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil GM P/N 12345616 (Canadian P/N 993182) or equivalent. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
3. Lubricate the SHLA bores of the cylinder head with clean engine oil GM P/N 12345616 (Canadian P/N 993182) or equivalent.

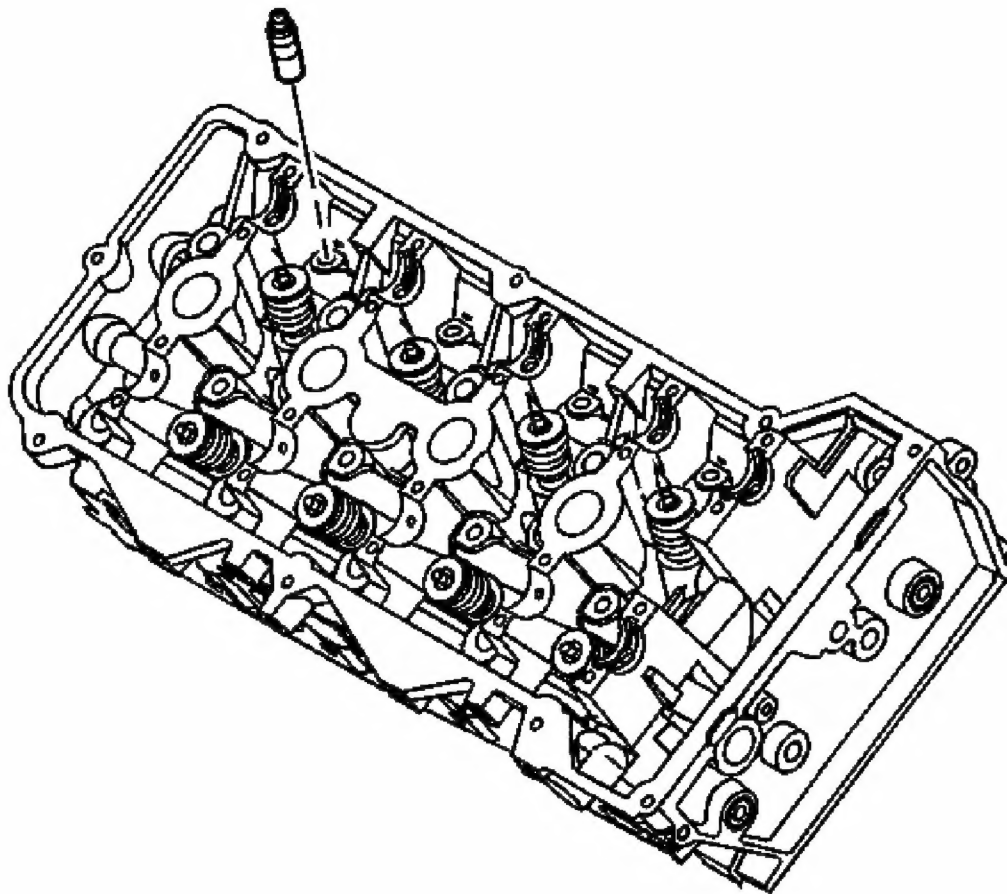


Fig. 2: View of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

4. Install the SHLAs.
5. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the SHLA sphere.

VALVE ROCKER ARM INSTALLATION - LEFT SIDE

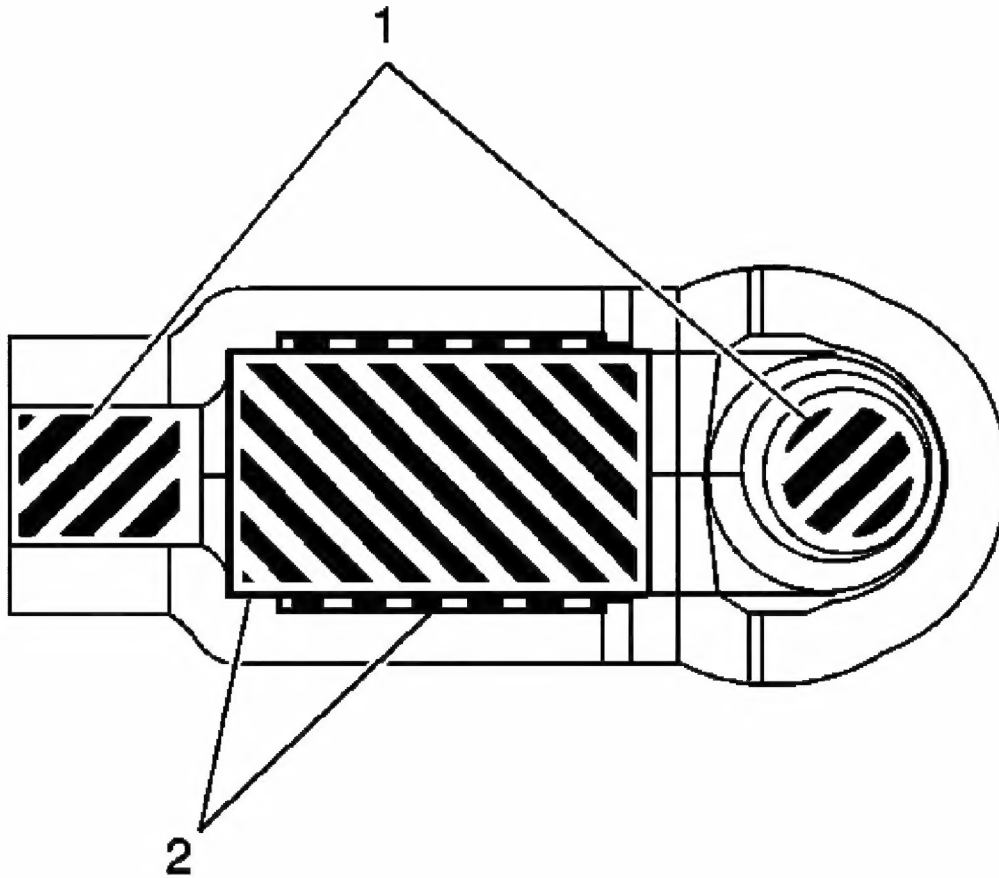


Fig. 3: Identifying Roller Pivot Pocket (2) & Valve Slot Areas (1) Of Camshaft Followers

Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the roller (2), pivot pocket and valve slot areas (1) of the camshaft followers.

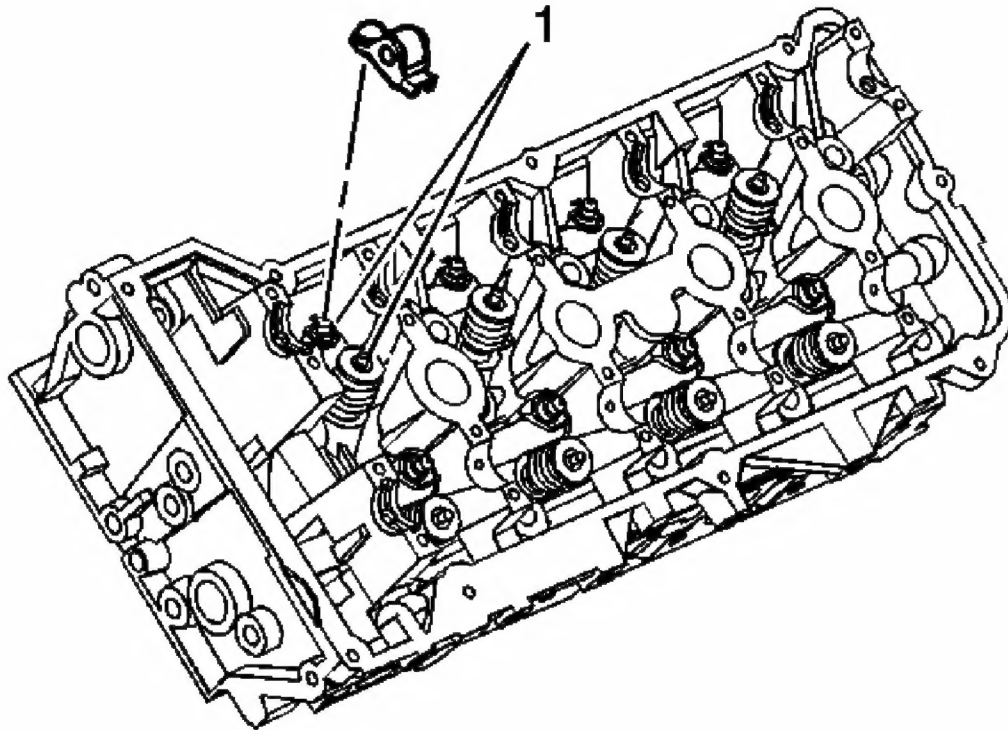


Fig. 4: Identifying the Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and SHLA (1). The rounded head of the follower goes on the SHLA while the flat end goes on the valve tip.

VALVE ROCKER ARM INSTALLATION - RIGHT SIDE

INSTALLATION PROCEDURE

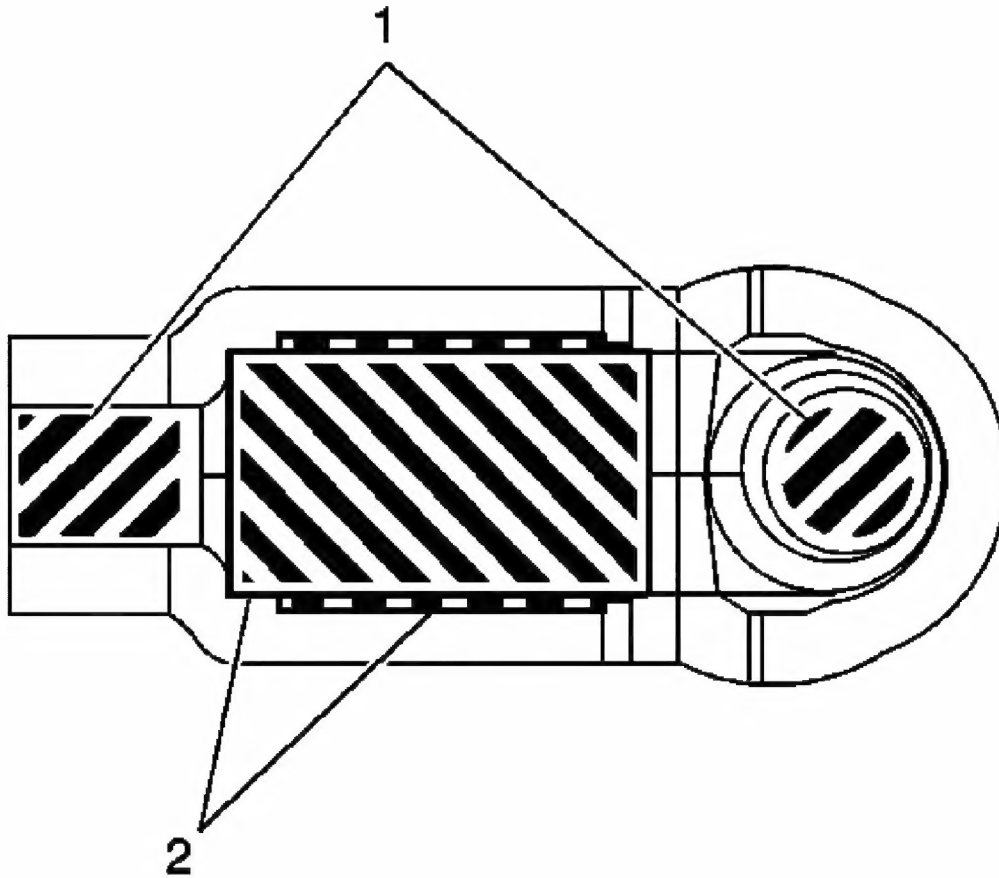


Fig. 5: Identifying Roller Pivot Pocket (2) & Valve Slot Areas (1) Of Camshaft Followers

Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the roller (2), pivot pocket and valve slot areas (1) of the camshaft followers.

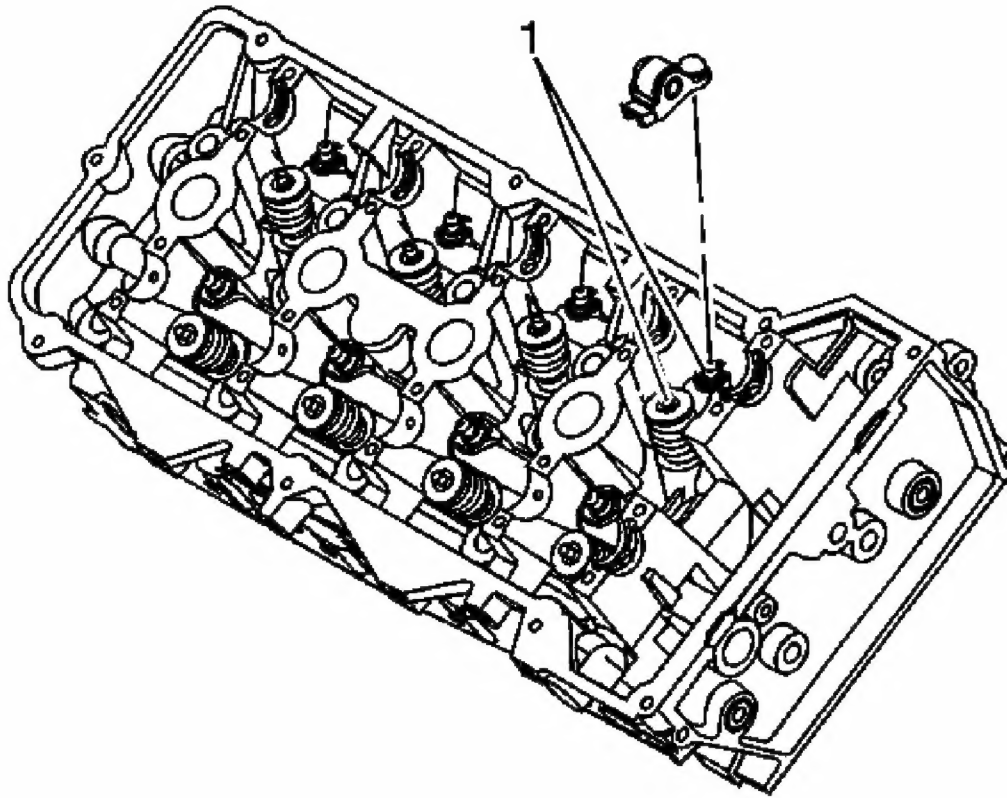


Fig. 6: Identifying Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and SHLA (1). The rounded head of the follower goes on the SHLA while the flat end goes on the valve tip.

EXHAUST CAMSHAFT INSTALLATION - LEFT SIDE

TOOLS REQUIRED

J 45059 Angle Meter

INSTALLATION PROCEDURE

1. Clean the camshaft journals, camshaft and the camshaft caps with a clean, lint-free cloth.

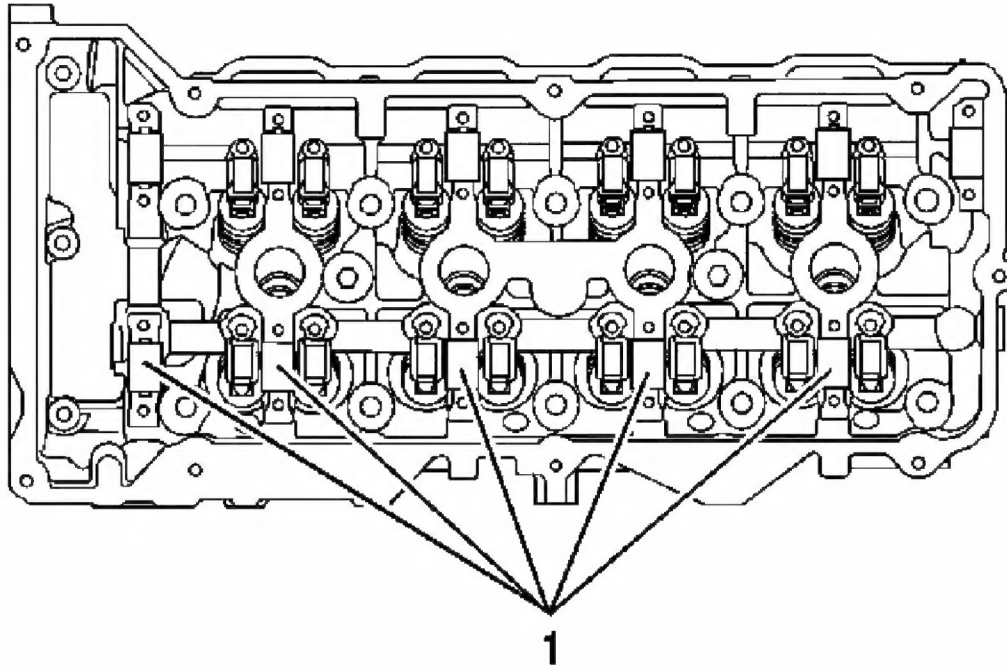


Fig. 7: Identifying Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft journals (1).

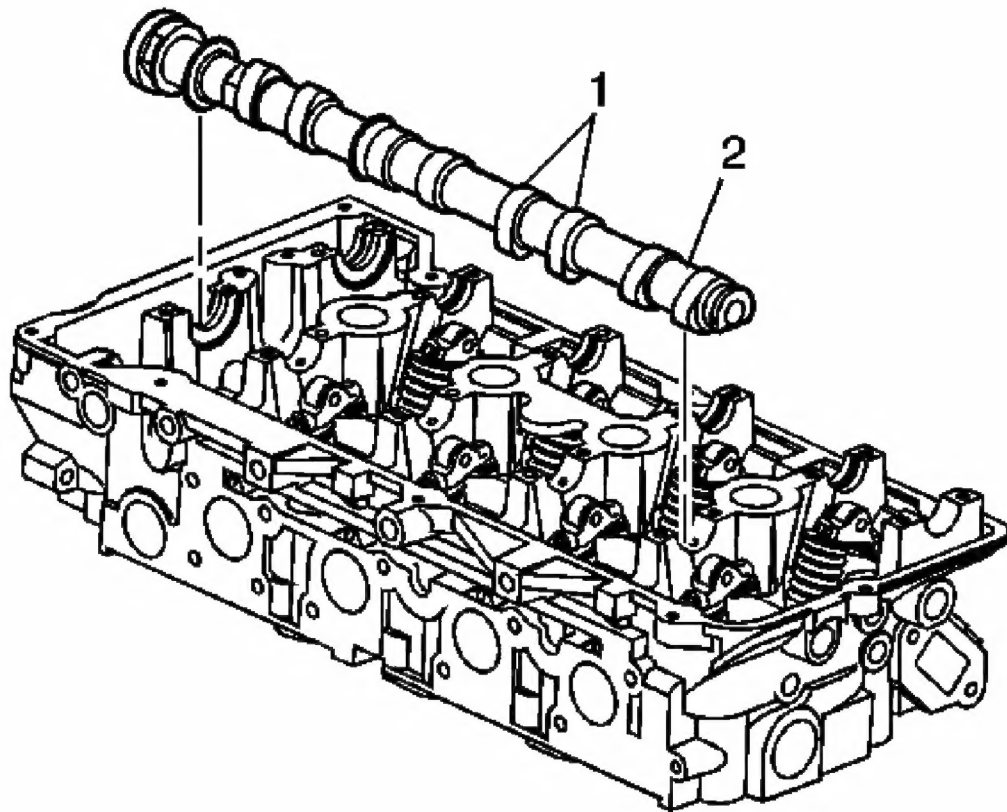


Fig. 8: Identifying Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS CORP.

3. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft lobes (1) and the camshaft journals (2).

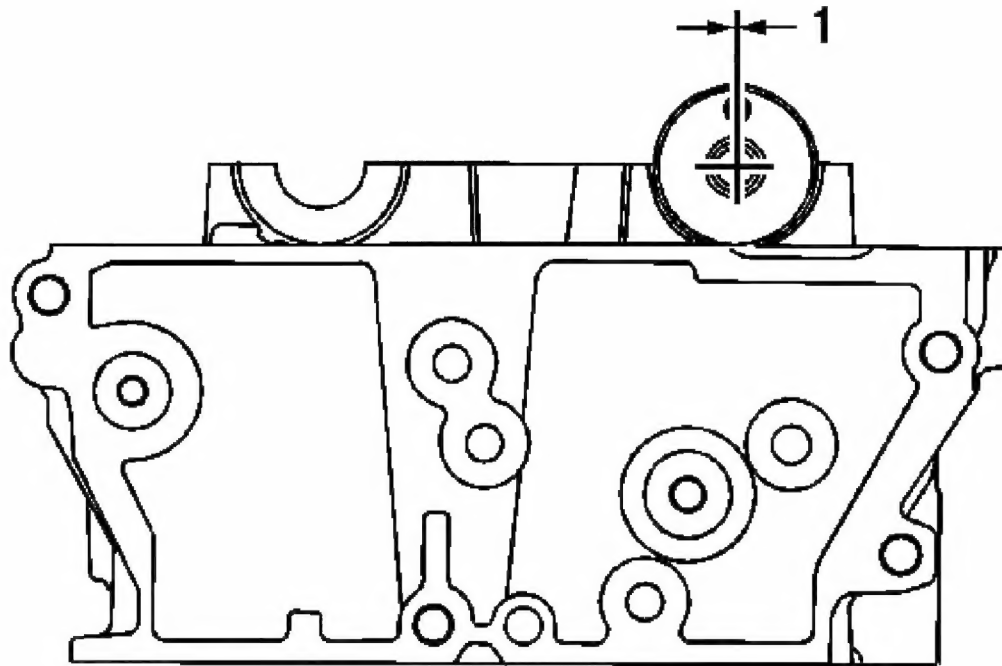


Fig. 9: Identifying Proper Camshaft Sprocket Drive Pin Positioning
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

4. Place the camshaft in the camshaft journals with the camshaft sprocket drive pins near the top of their rotation (1) and the camshaft lobes in a neutral position. The camshaft can be identified by a stamping near the rear journal. For example: L-EXH is defined as left bank exhaust.

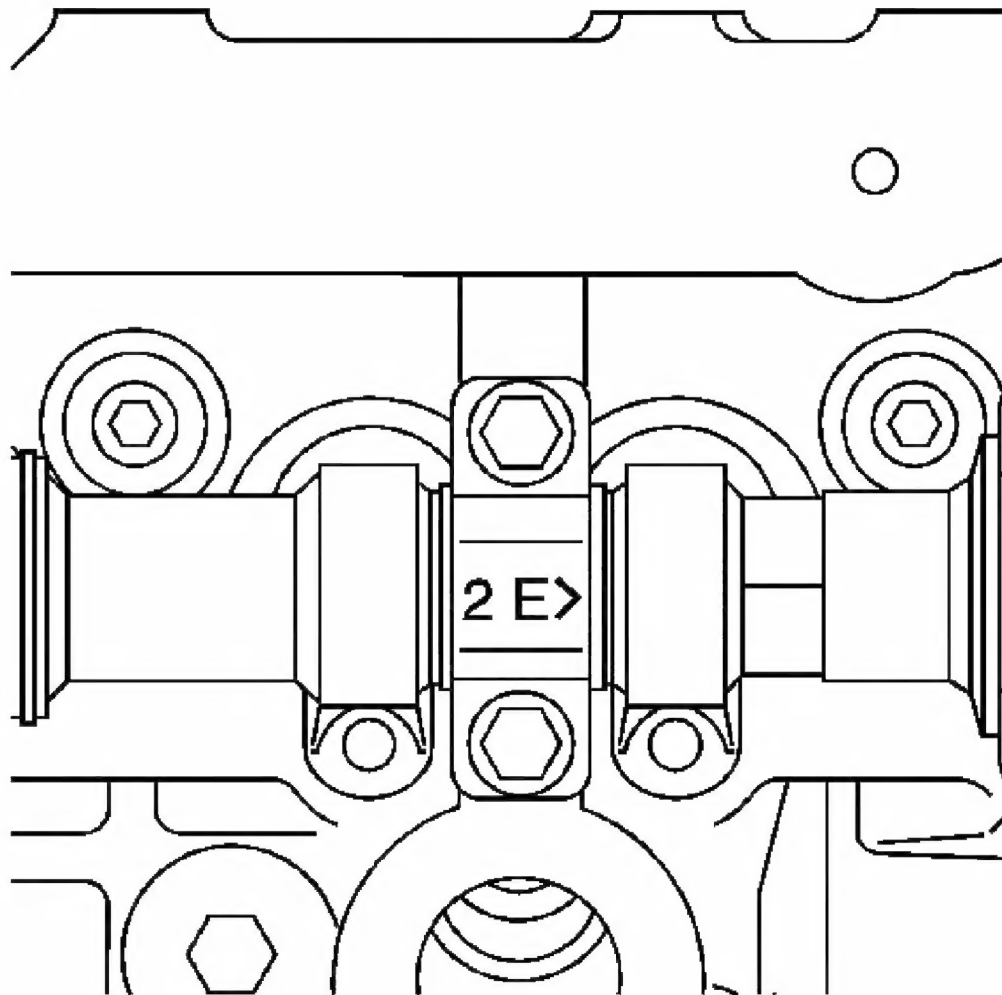


Fig. 10: View Of Exhaust Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

5. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow should point toward the front of the engine.
 - The number indicates the position from the front of the engine.
 - The "E" indicates the exhaust camshaft.
6. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the left exhaust camshaft bearing cap journals.

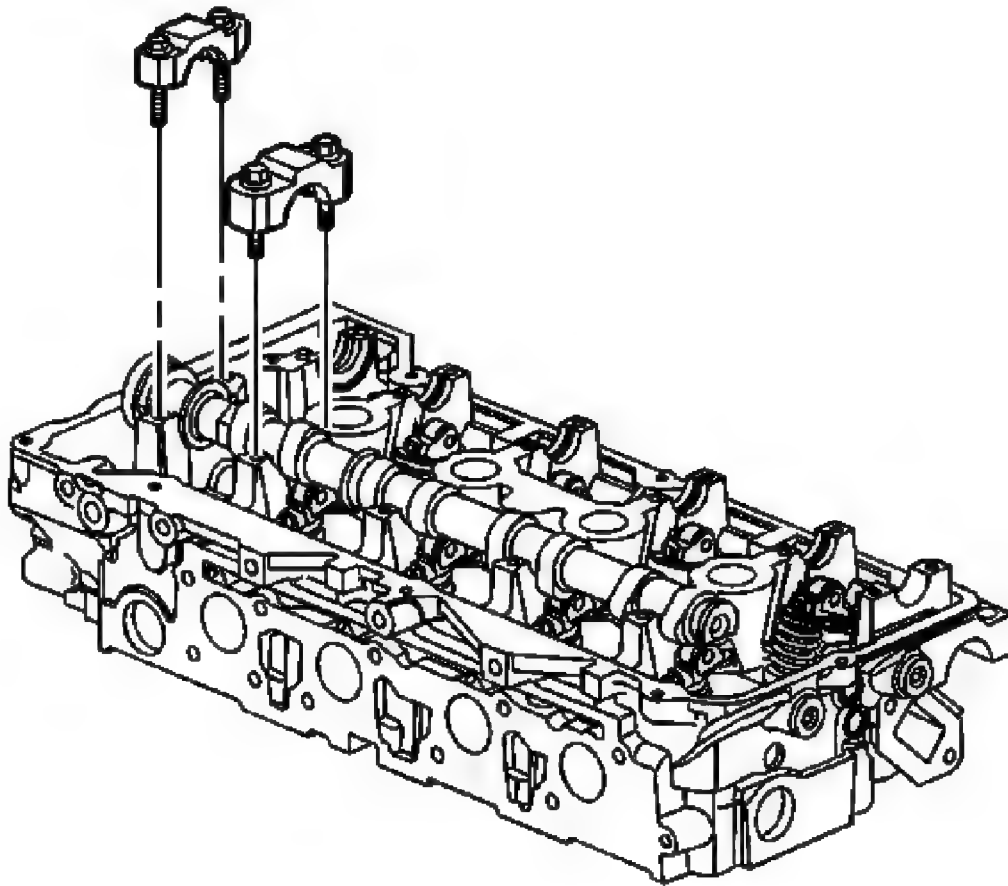


Fig. 11: View Of Left Exhaust Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the left exhaust camshaft bearing caps according to the identifications marks.
8. Hand start all the left exhaust camshaft bearing cap bolts.

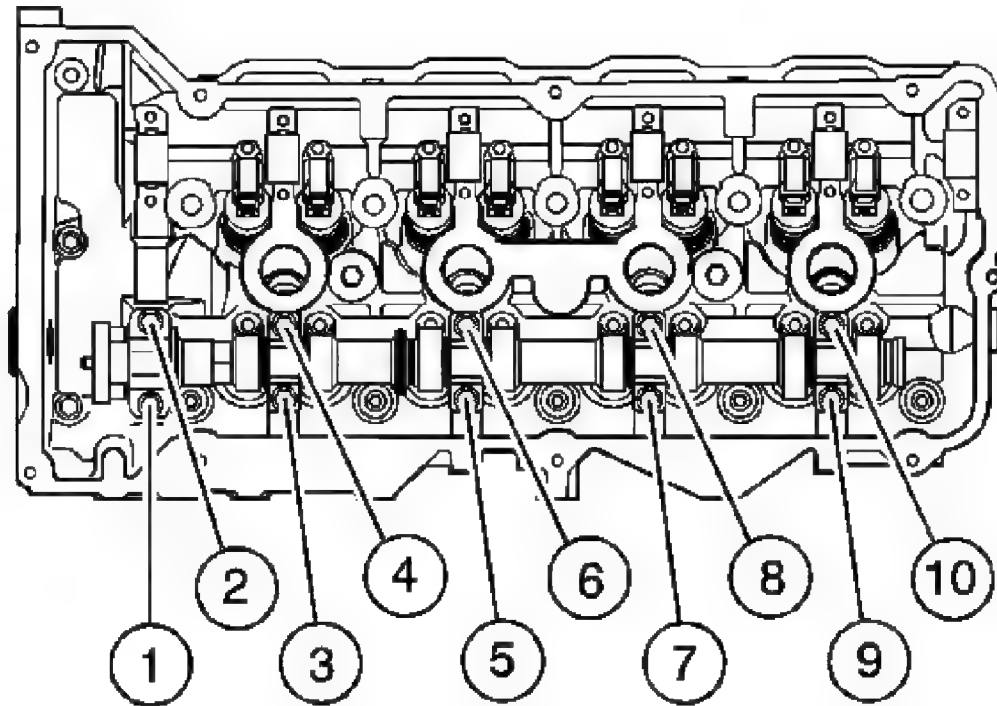


Fig. 12: Identifying Left Exhaust Camshaft Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

9. Install the left cylinder head exhaust camshaft bearing cap bolts.

1. First Pass

Tighten: Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten: Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059** .

INTAKE CAMSHAFT INSTALLATION - LEFT SIDE

TOOLS REQUIRED

J 45059 Angle Meter

INSTALLATION PROCEDURE

1. Clean the camshaft journals, camshaft and the camshaft caps with a clean, lint-free cloth.

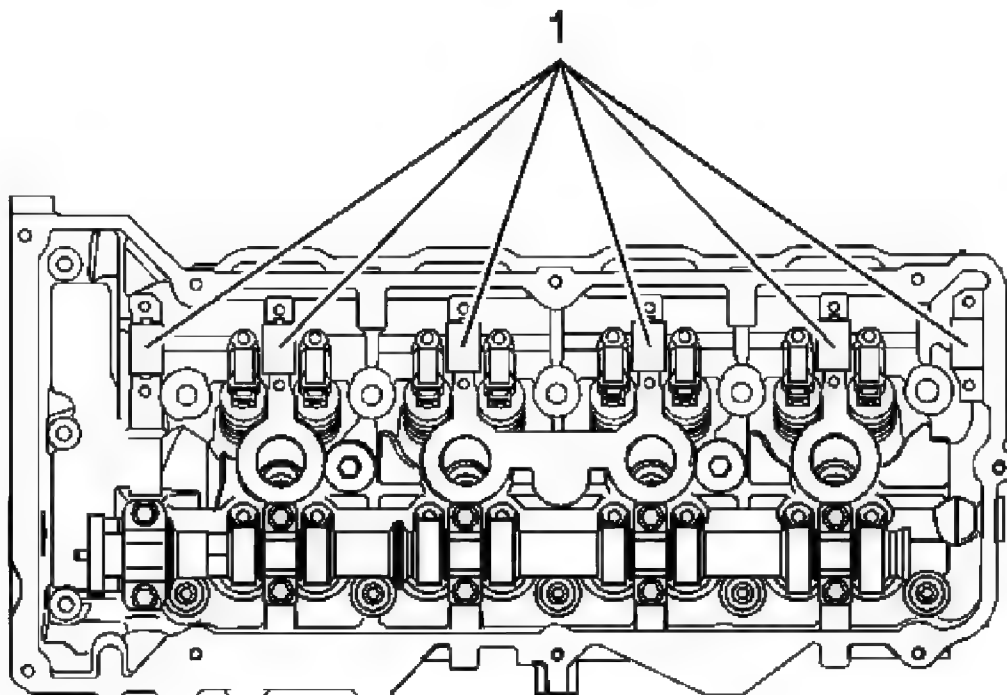


Fig. 13: View of Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft journals (1).

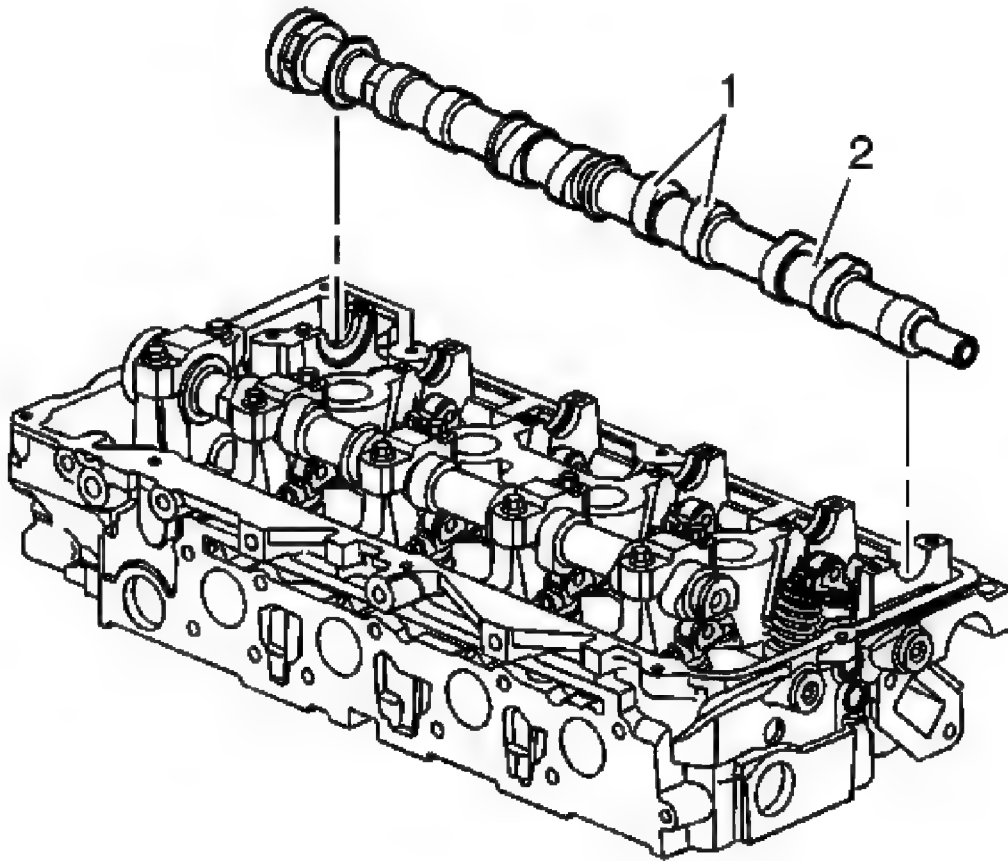


Fig. 14: View of Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS CORP.

3. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft lobes (1) and the camshaft journals (2).

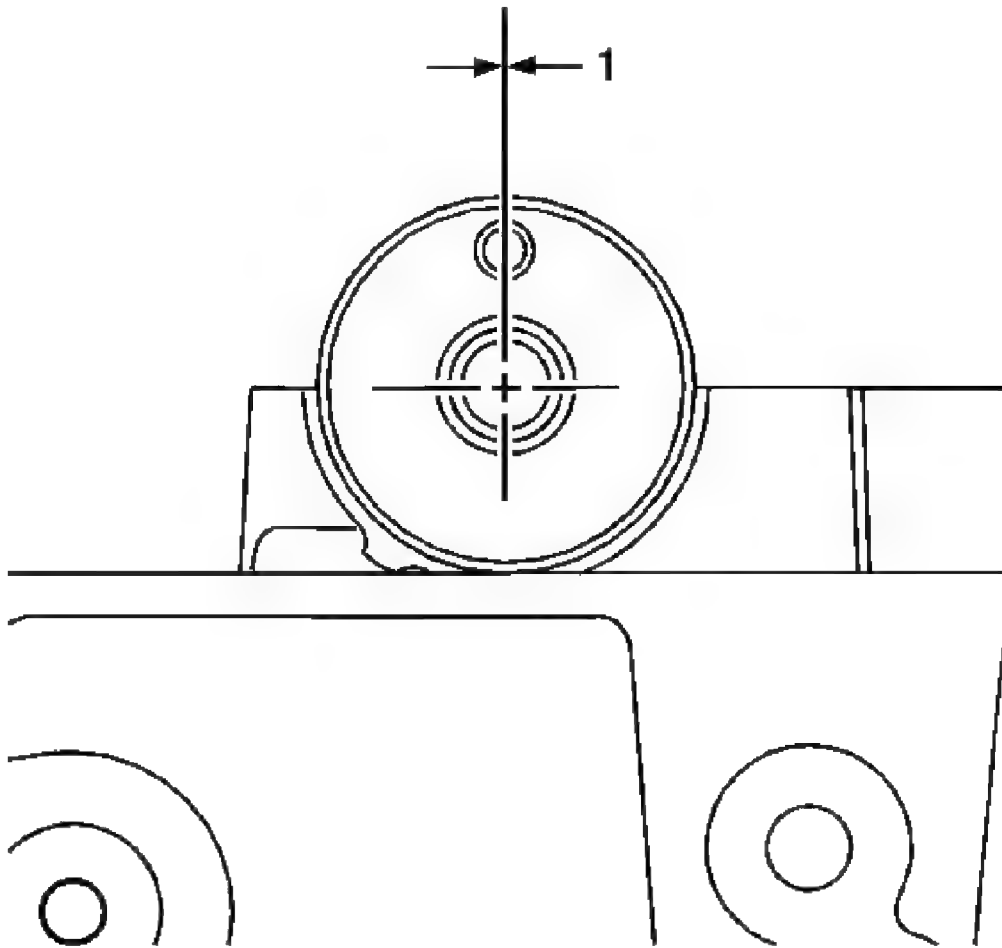


Fig. 15: View of Correct Camshaft Sprocket Drive Pin Positioning
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

4. Place the camshaft in the camshaft journals with the camshaft sprocket drive pins near the top of their rotation (1) and the camshaft lobes in a neutral position. The camshaft can be identified by a stamping near the rear journal. For example: L-INT is defined as left bank intake.

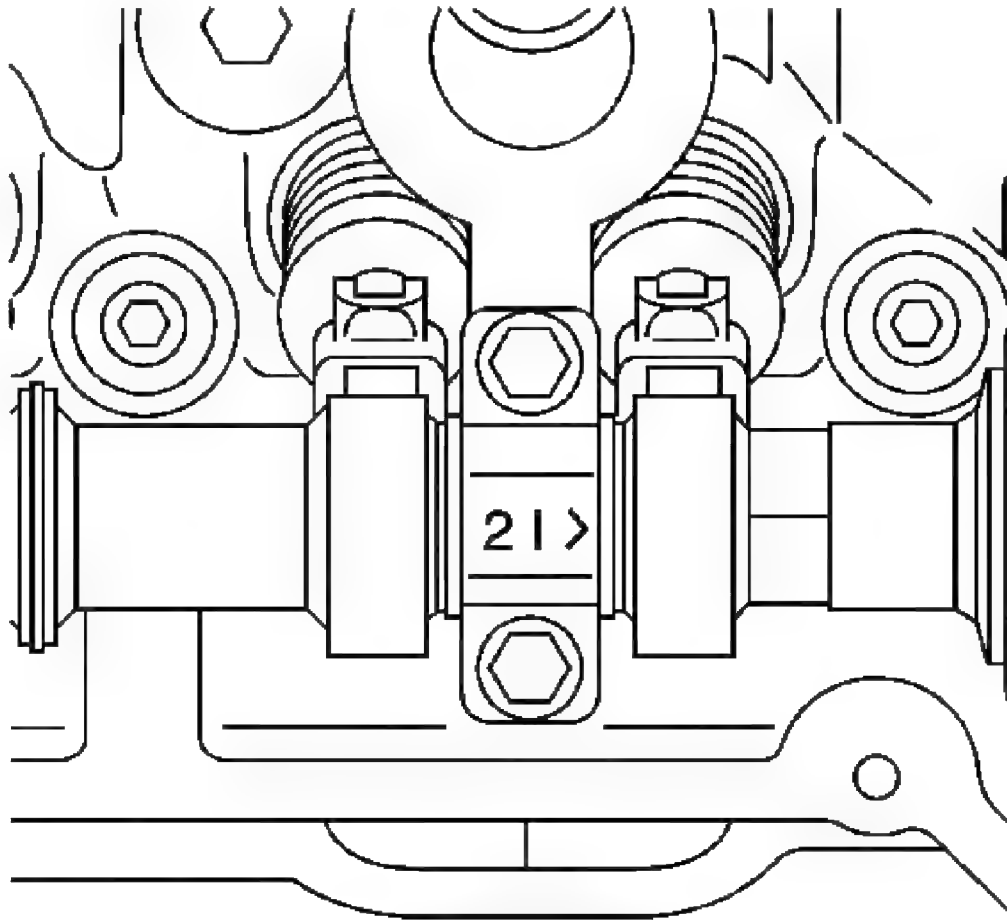


Fig. 16: View Of Intake Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

5. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow should point toward the front of the engine.
 - The number indicates the position from the front of the engine.
 - The "I" indicates the intake camshaft.
6. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the left intake camshaft bearing cap journals.

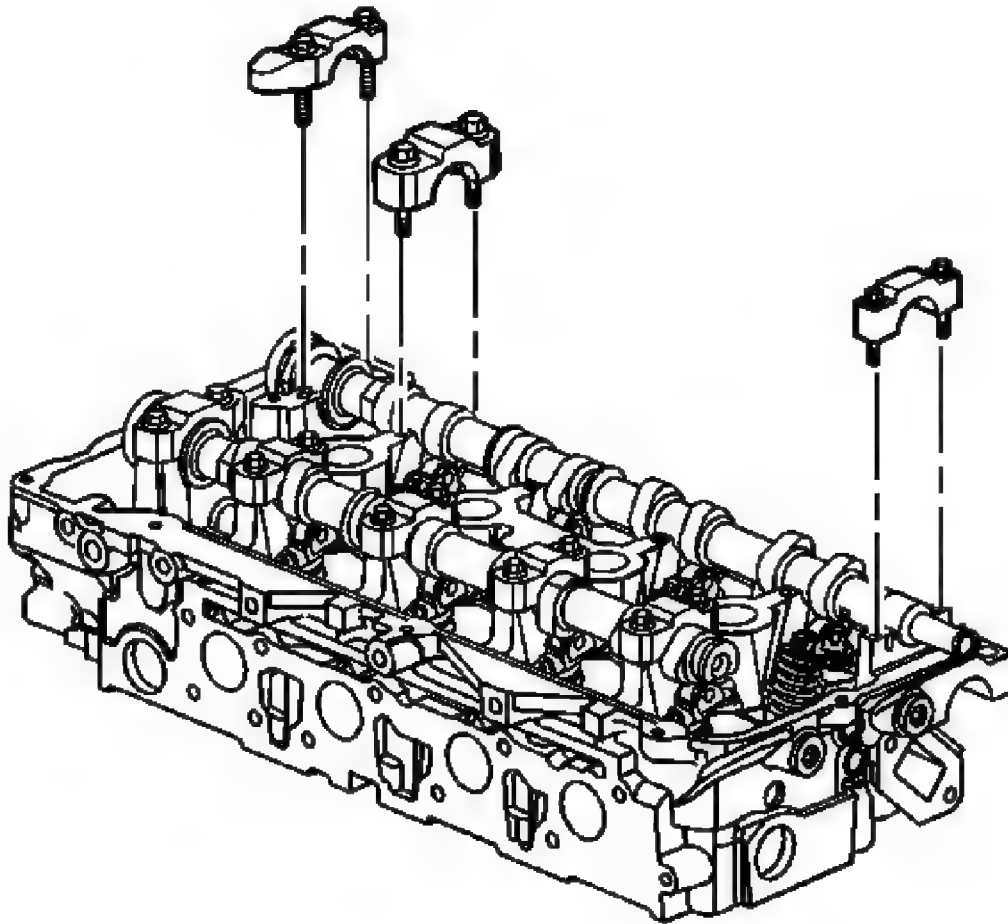


Fig. 17: View of Left Intake Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

7. Install the left intake camshaft bearing caps according to the identifications marks.
8. Hand start all the left intake camshaft bearing cap bolts.

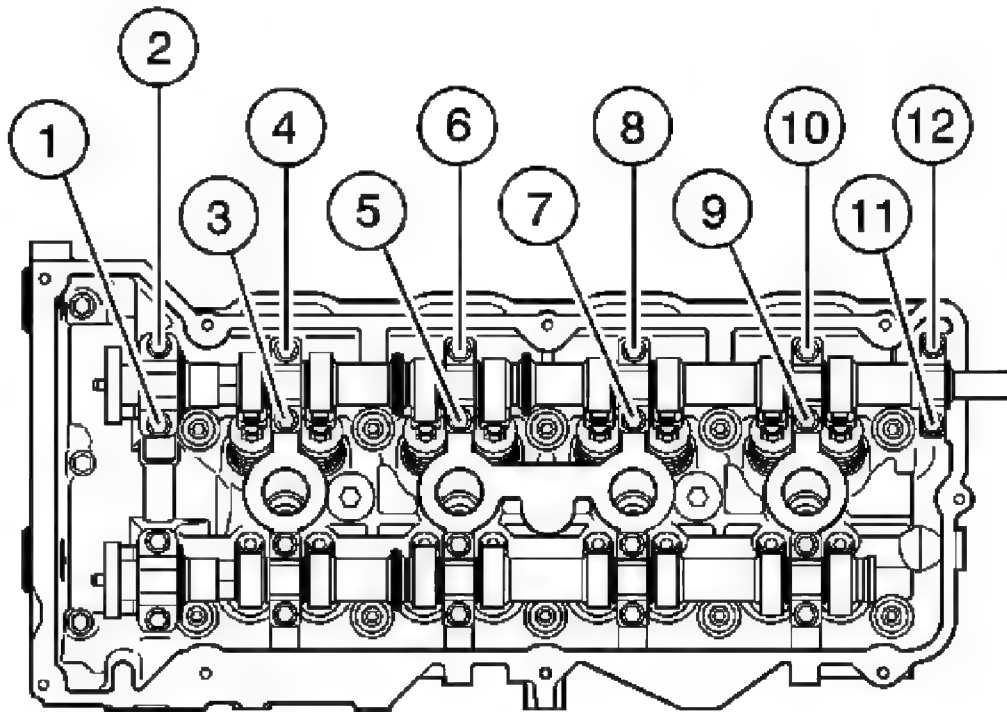


Fig. 18: Identifying Left Intake Camshaft Cap Bolts Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

9. Install the left cylinder head intake camshaft bearing cap bolts.

1. First Pass

Tighten: Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten: Tighten the camshaft bearing cap bolts an additional 30 degrees using the J 45059 .

EXHAUST CAMSHAFT INSTALLATION - RIGHT SIDE

TOOLS REQUIRED

J 45059 Angle Meter

INSTALLATION PROCEDURE

1. Clean the camshaft journals, camshaft and the camshaft caps with a clean, lint-free cloth.

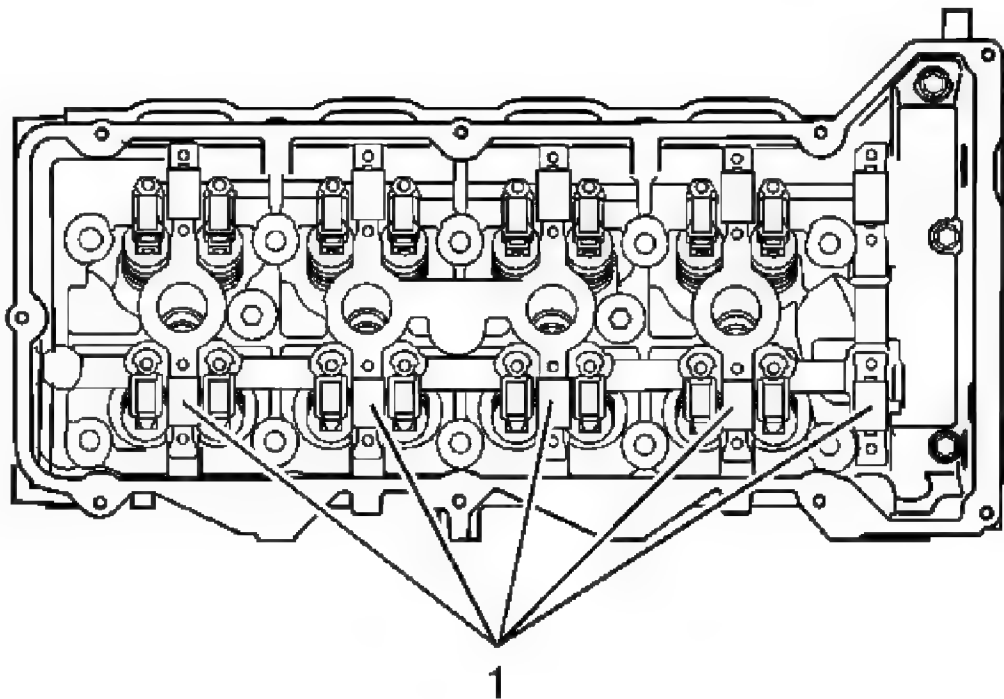


Fig. 19: View of Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft journals (1).

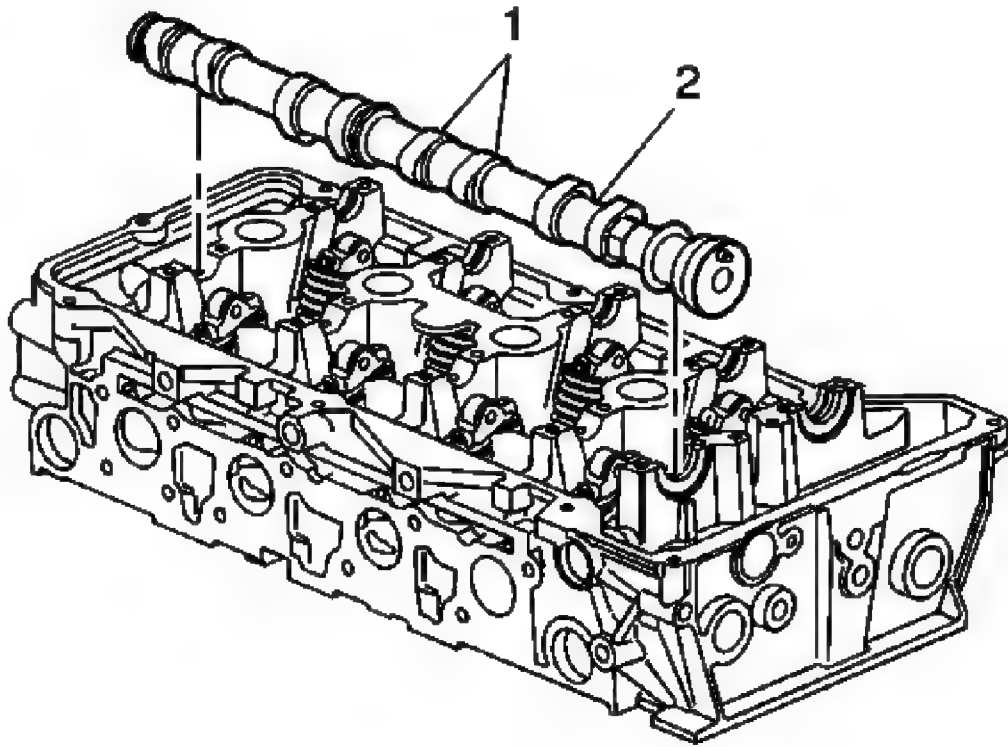


Fig. 20: Identifying Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS CORP.

3. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft lobes (1) and the camshaft journals (2).

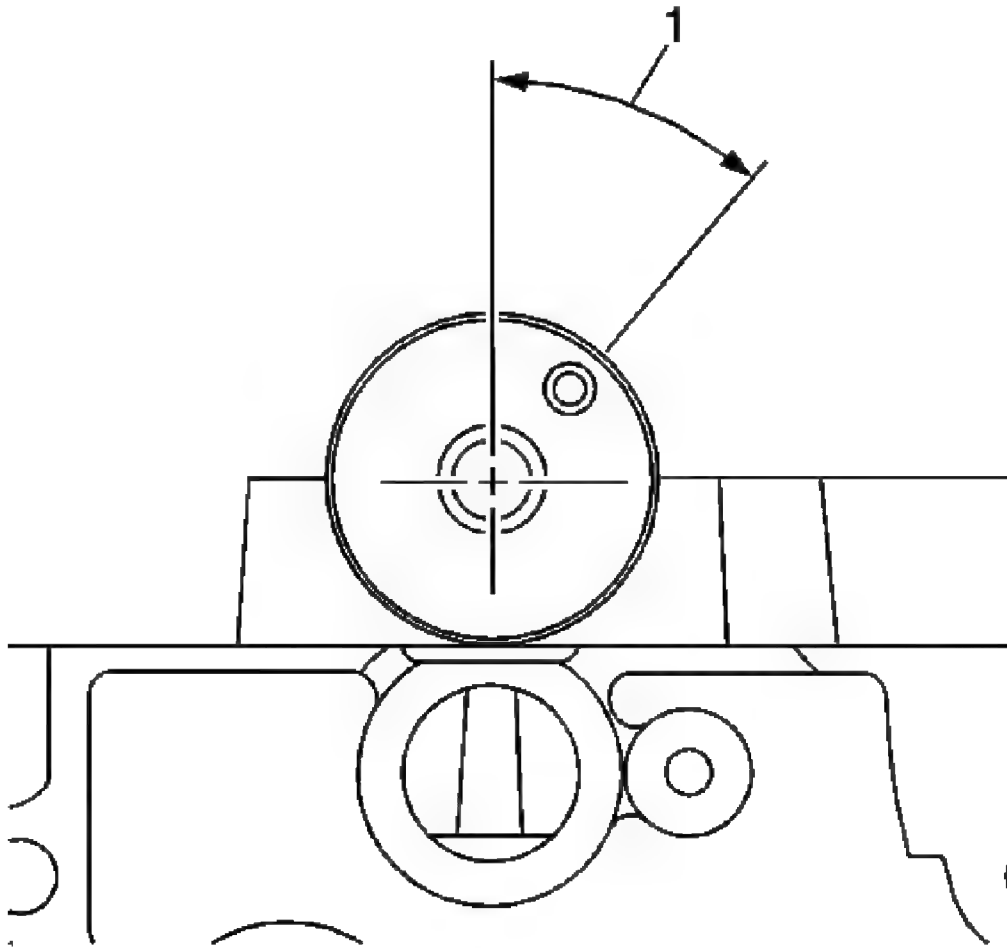


Fig. 21: Correct Camshaft Sprocket Drive Pin Location
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

4. Place the camshaft in the camshaft journals with the camshaft sprocket drive pins near the 45-60 degree location (1), clockwise from the top of their rotation and the camshaft lobes in a neutral position. The camshaft can be identified by a stamping near the rear journal. For example: R-EXH is defined as right bank exhaust.

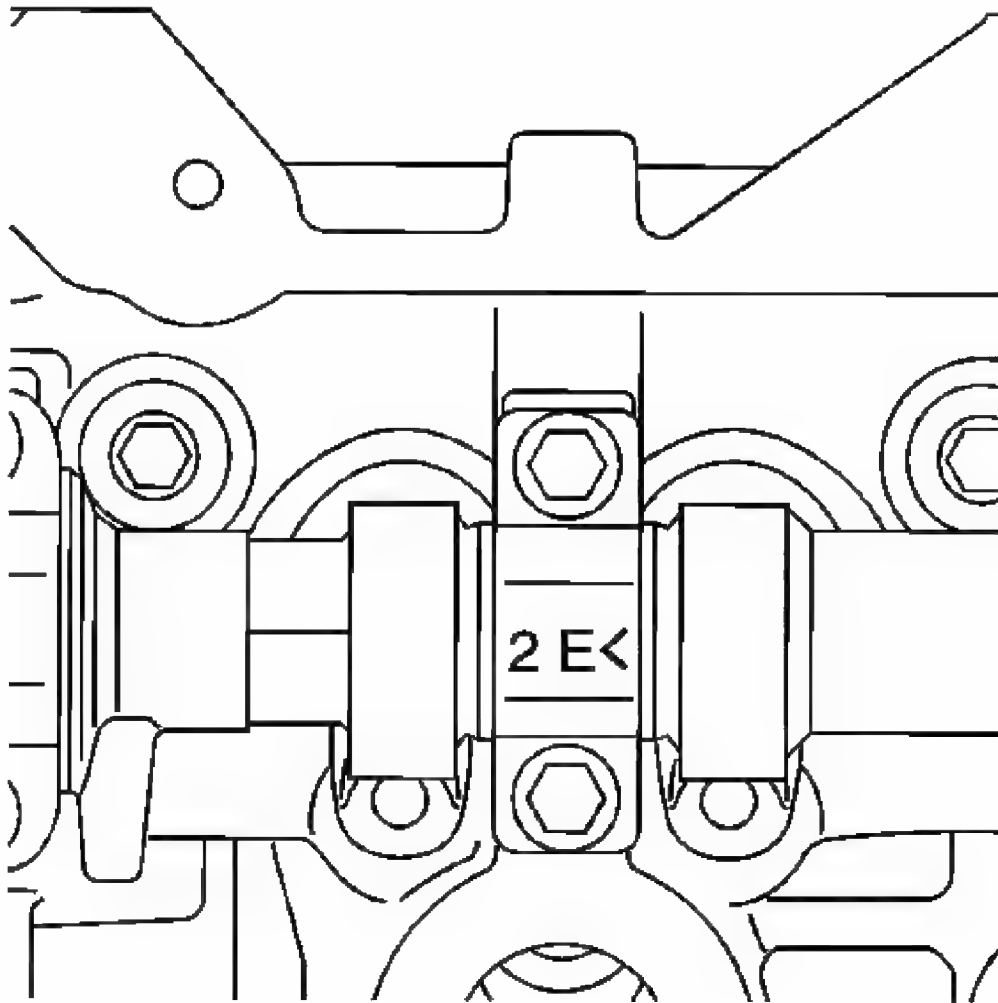


Fig. 22: View Of Exhaust Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

5. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow should point toward the front of the engine.
 - The number indicates the position from the front of the engine.
 - The "E" indicates the exhaust camshaft.
6. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the right exhaust camshaft bearing cap journals.

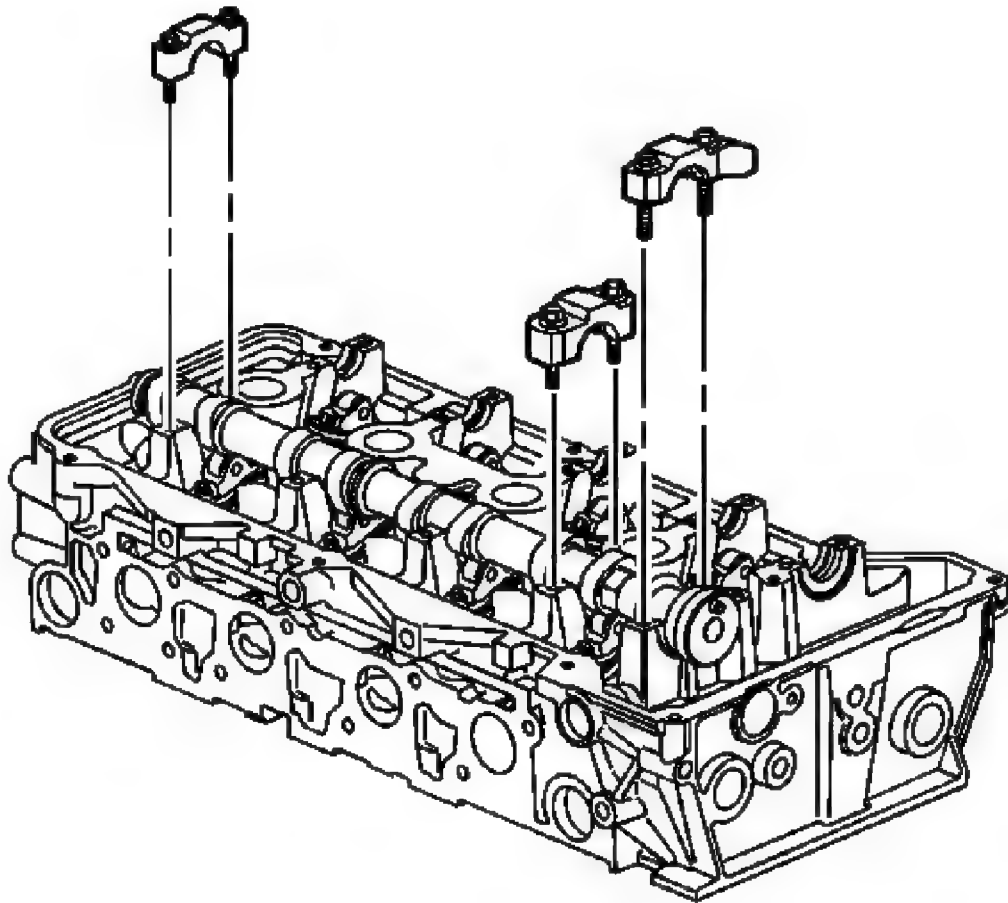


Fig. 23: View of Right Exhaust Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

7. Install the right exhaust camshaft bearing caps according to the identifications marks.
8. Hand start all the right exhaust camshaft bearing cap bolts.

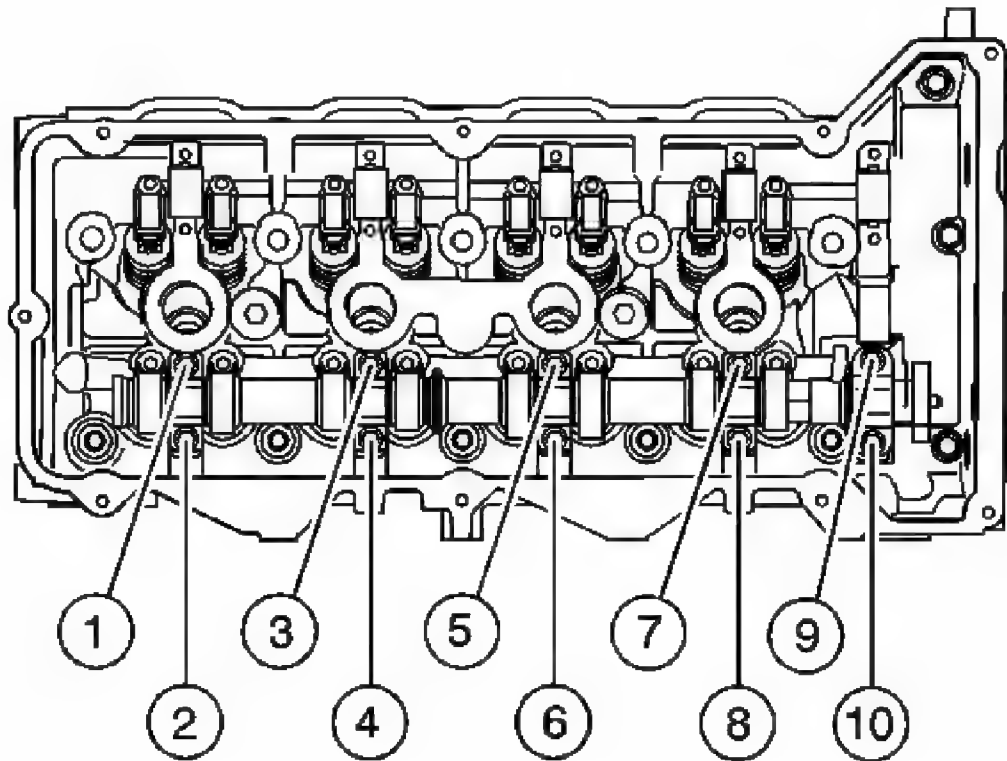


Fig. 24: Identifying Right Exhaust Camshaft Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

9. Install the right cylinder head exhaust camshaft bearing cap bolts.

1. First Pass

Tighten: Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten: Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059** .

INTAKE CAMSHAFT INSTALLATION - RIGHT SIDE

TOOLS REQUIRED

J 45059 Angle Meter

INSTALLATION PROCEDURE

1. Clean the camshaft journals, camshaft and the camshaft caps with a clean, lint-free cloth.

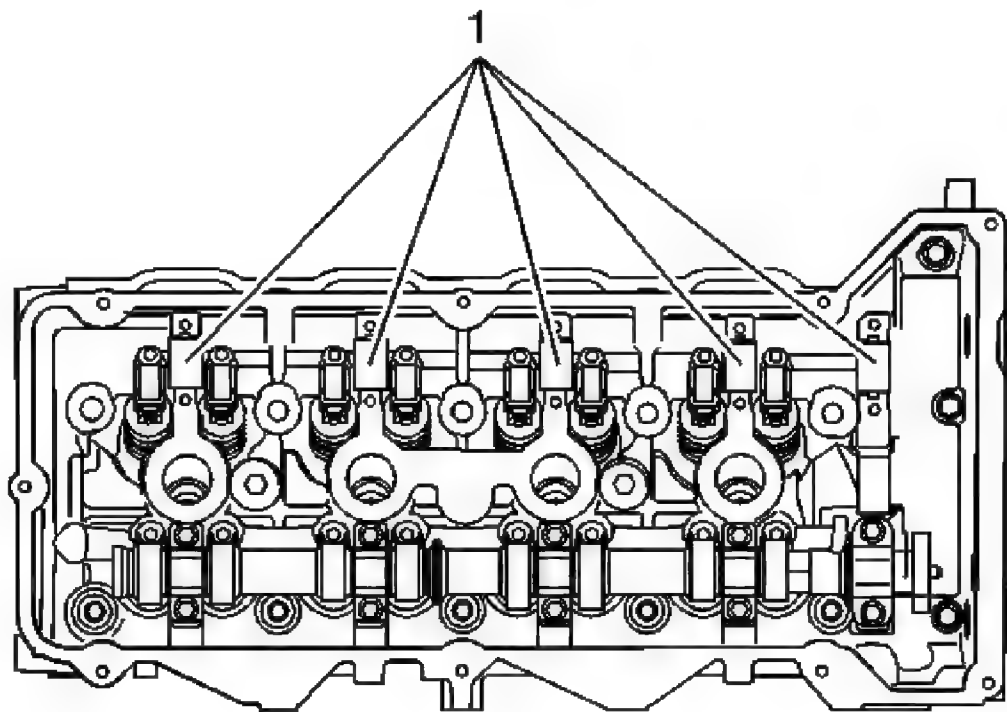


Fig. 25: View of Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft journals (1).

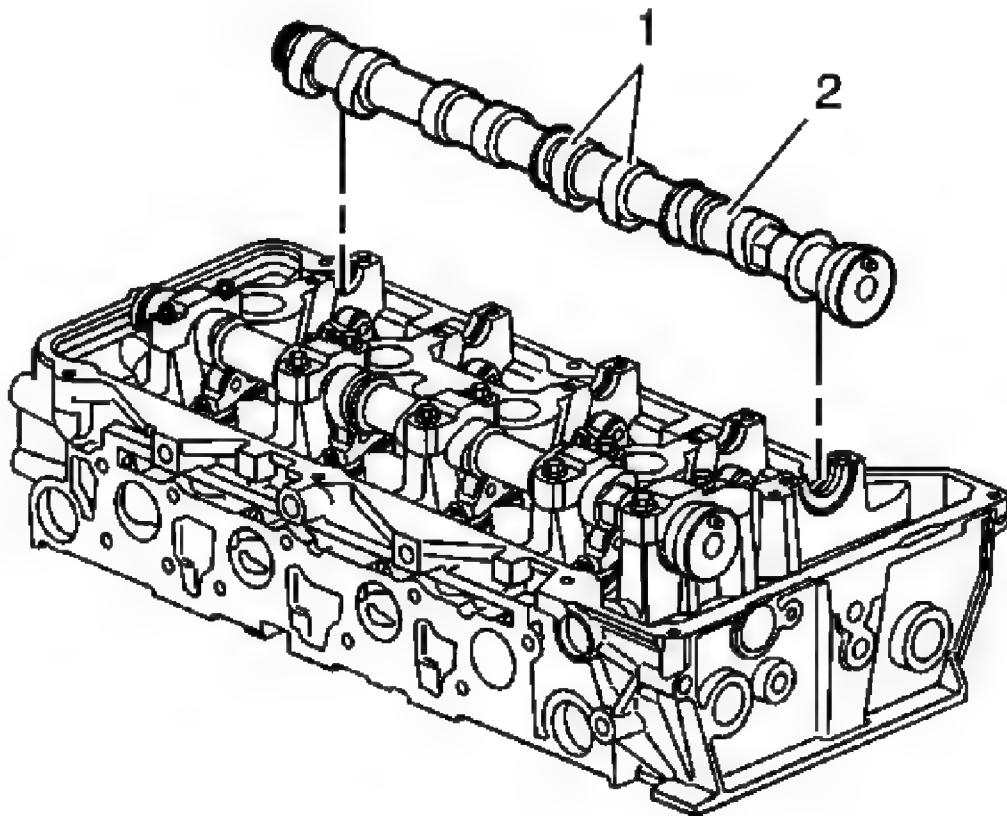


Fig. 26: View of Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS CORP.

3. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the camshaft lobes (1) and the camshaft journals (2).

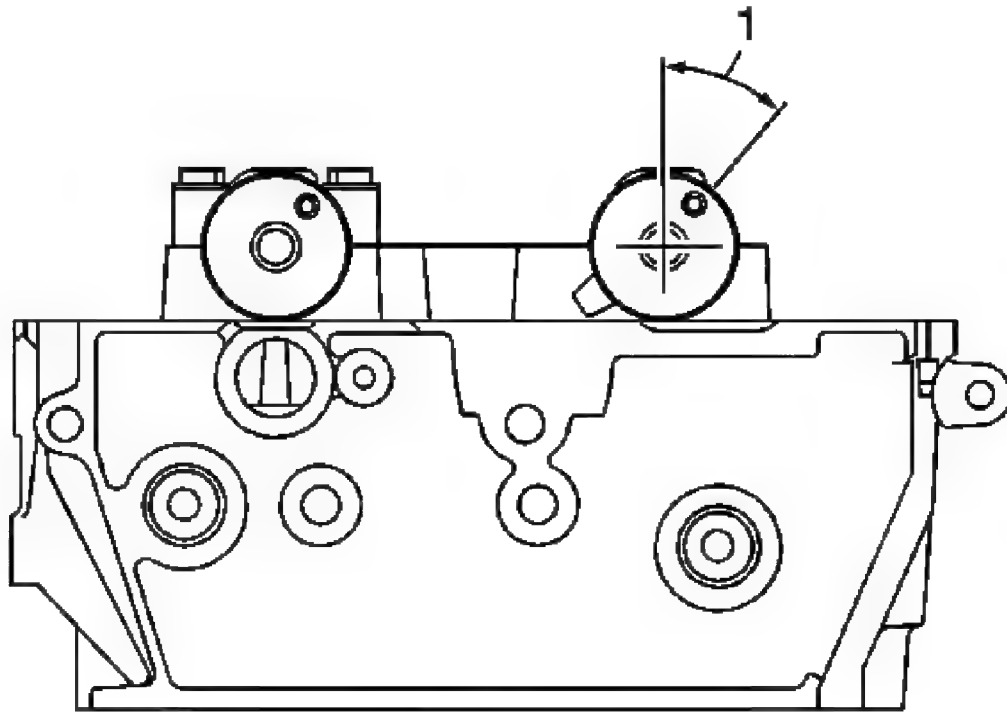


Fig. 27: Proper Camshaft Sprocket Drive Pin Location
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

4. Place the camshaft in the camshaft carriers with the camshaft sprocket drive pins near the 45-60 degree location (1), clockwise from the top of their rotation and the camshaft lobes in a neutral position. The camshafts can be identified by a stamping near the rear journal. For example: L-EXH is defined as left bank exhaust.

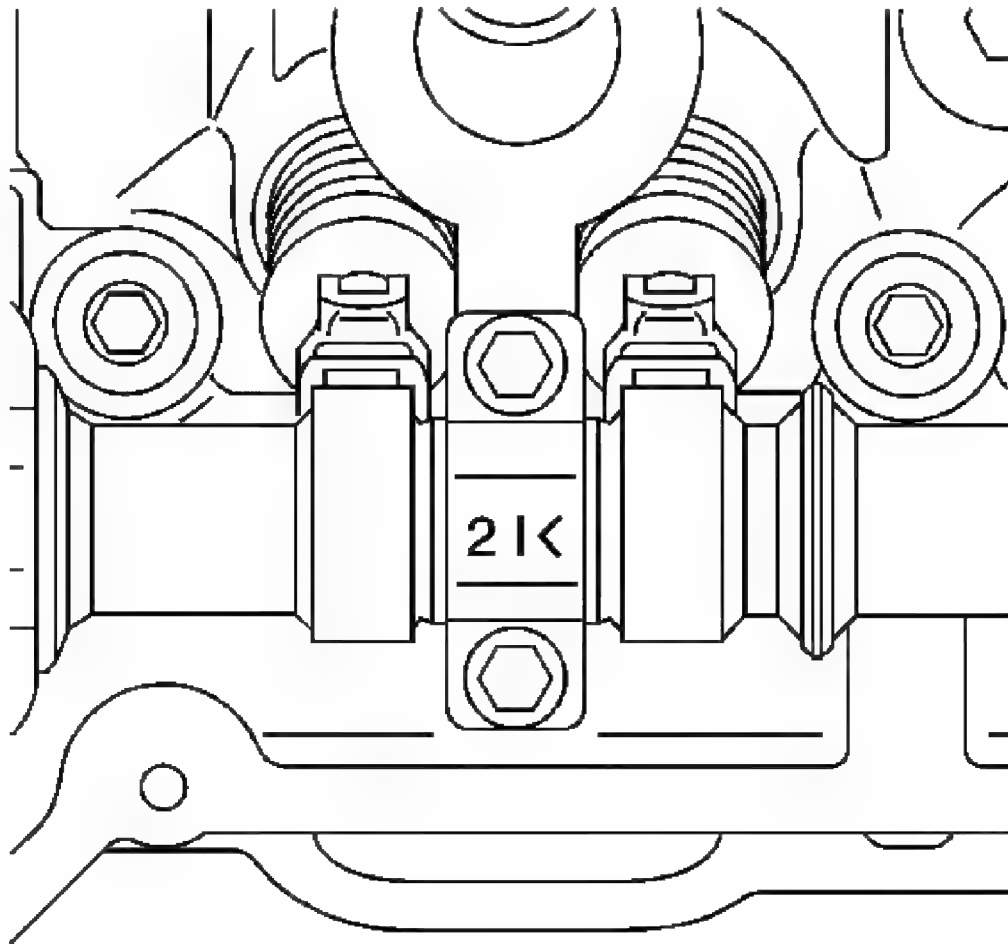


Fig. 28: View Of Intake Camshaft Bearing Cap Markings

Courtesy of GENERAL MOTORS CORP.

5. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow should point toward the front of the engine.
 - The number indicates the position from the front of the engine.
 - The "I" indicates the intake camshaft.
6. Apply a liberal amount of lubricant GM P/N 12345001 (Canadian P/N 992704) or equivalent to the right intake camshaft bearing cap journals.

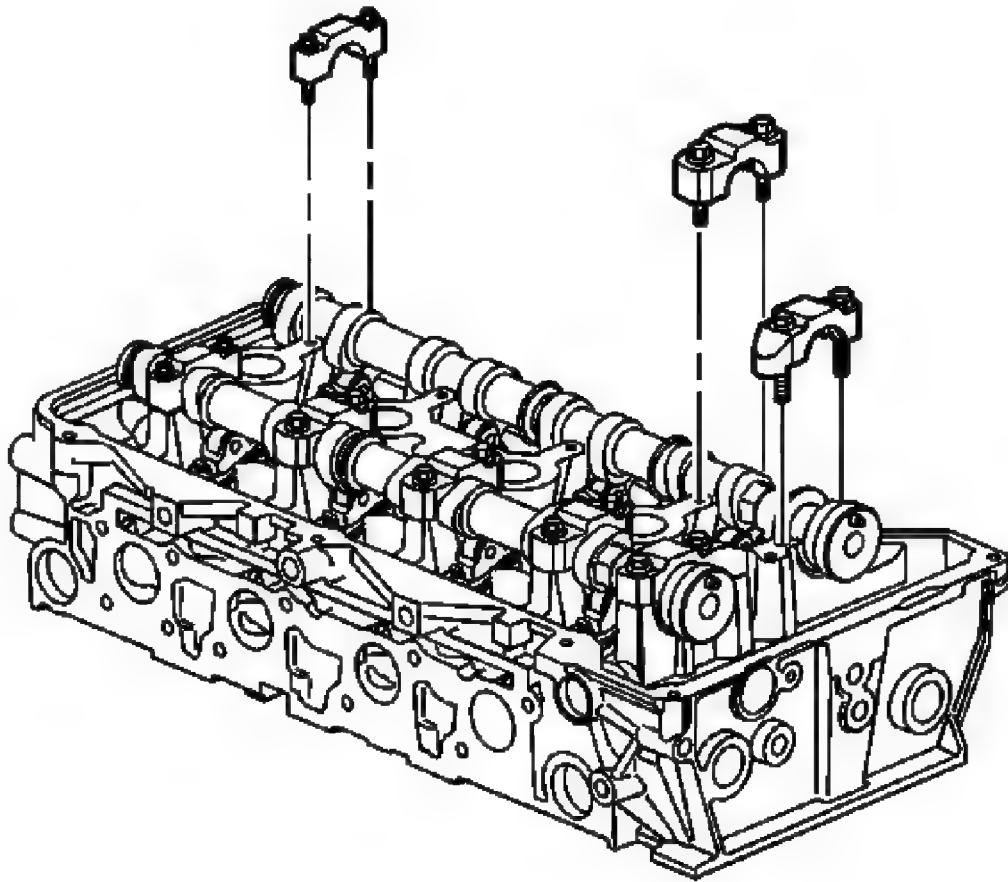


Fig. 29: View of Right Intake Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

7. Install the right intake camshaft bearing caps according to the identifications marks.
8. Hand start all the right intake camshaft bearing cap bolts.

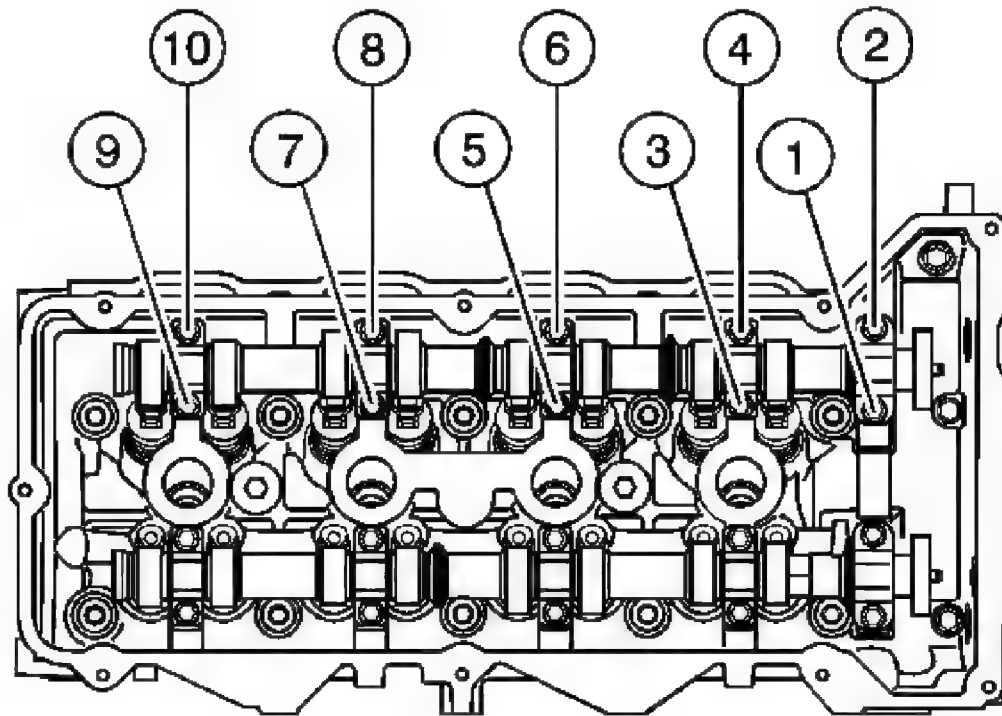


Fig. 30: Identifying Right Intake Camshaft Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

IMPORTANT: Ensure each valve rocker arm is properly aligned to the valve tip, the valve lifter and the camshaft lobe. Inspect the alignment prior to and after the camshaft caps are tightened to specifications.

9. Install the right cylinder head intake camshaft bearing cap bolts.
 1. First Pass

Tighten: Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).

2. Final Pass

Tighten: Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059** .

CAMSHAFT INTERMEDIATE DRIVE SHAFT INSTALLATION

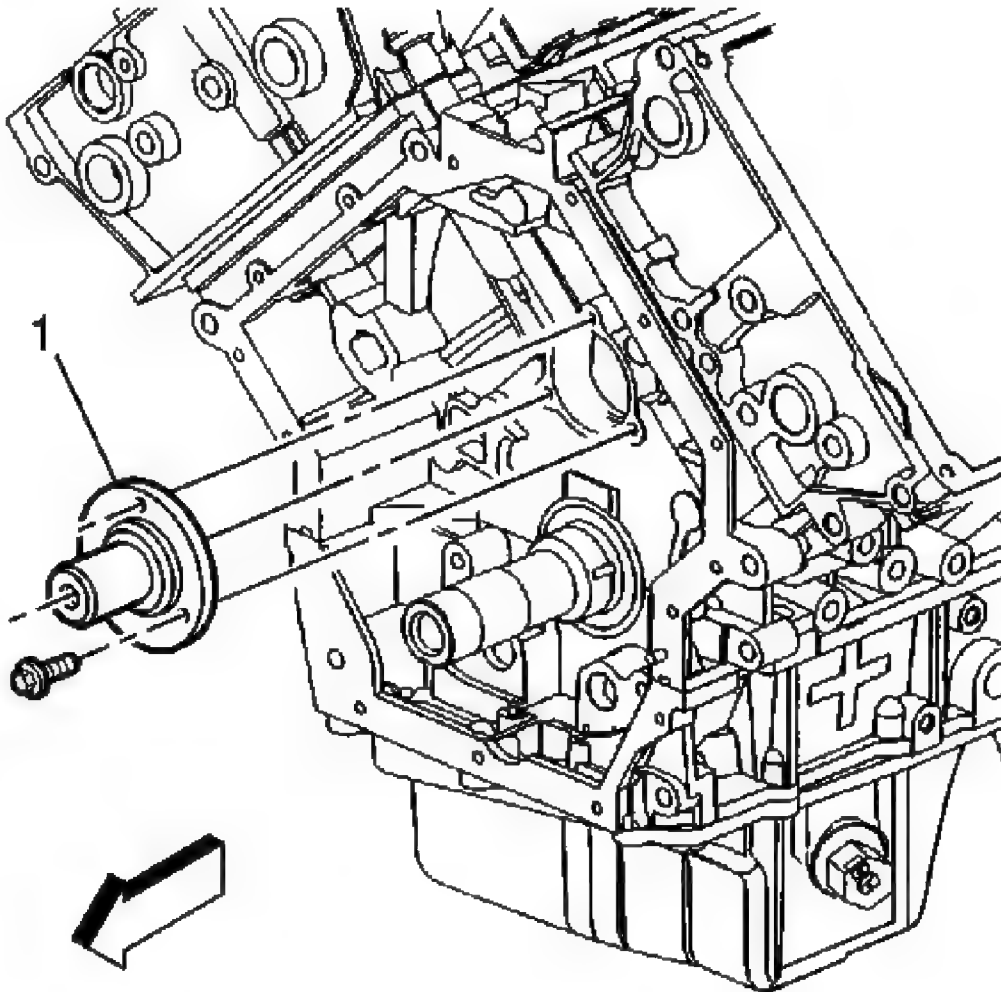


Fig. 31: Identifying Camshaft Intermediate Driveshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

Install the intermediate sprocket shaft (1) and the retaining bolts.

Tighten: Tighten the intermediate sprocket shaft bolts to 15 N.m (11 lb ft).

PRIMARY CAMSHAFT DRIVE CHAIN INSTALLATION

TOOLS REQUIRED

J 39946 Crankshaft Socket - See **Special Tools** .

INSTALLATION PROCEDURE

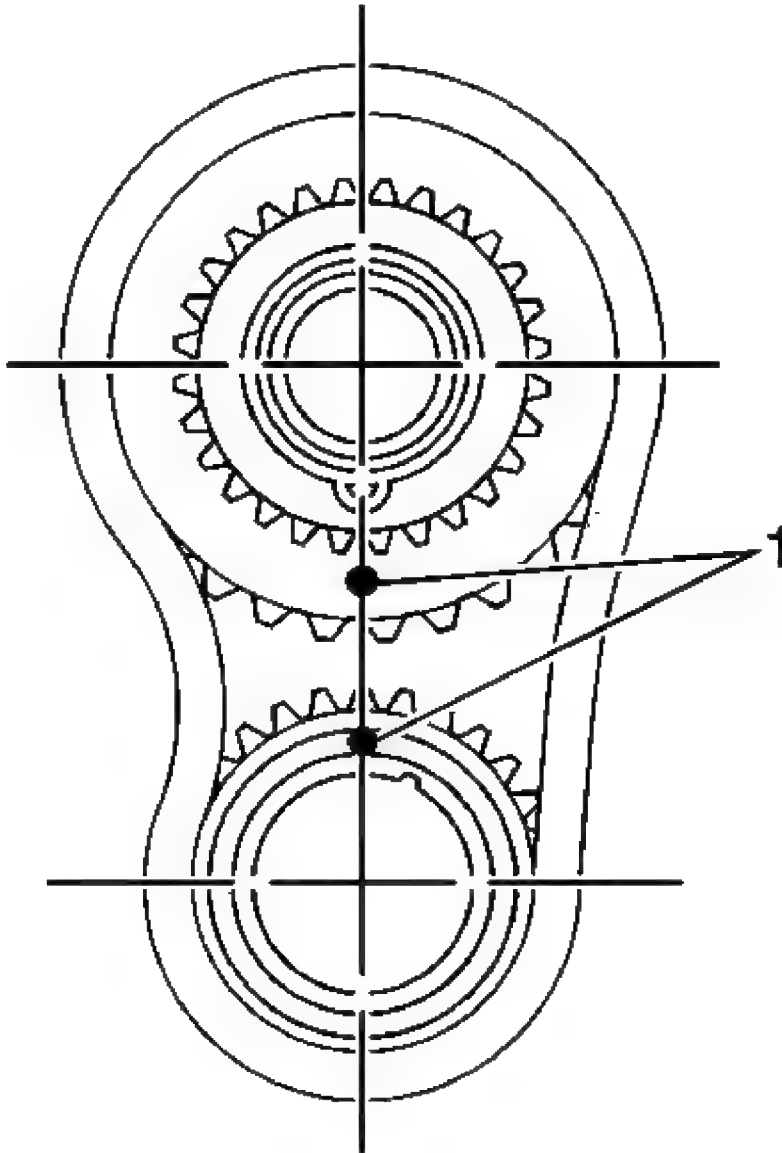


Fig. 32: Aligning Timing Marks Of Camshaft Intermediate & Crankshaft Sprockets

Courtesy of GENERAL MOTORS CORP.

1. Install the primary camshaft drive chain on the camshaft intermediate drive shaft sprocket

and crankshaft sprocket.

2. Align the timing marks (1) of the camshaft intermediate drive shaft sprocket and crankshaft sprocket. Ensure the marks are aligned vertically.

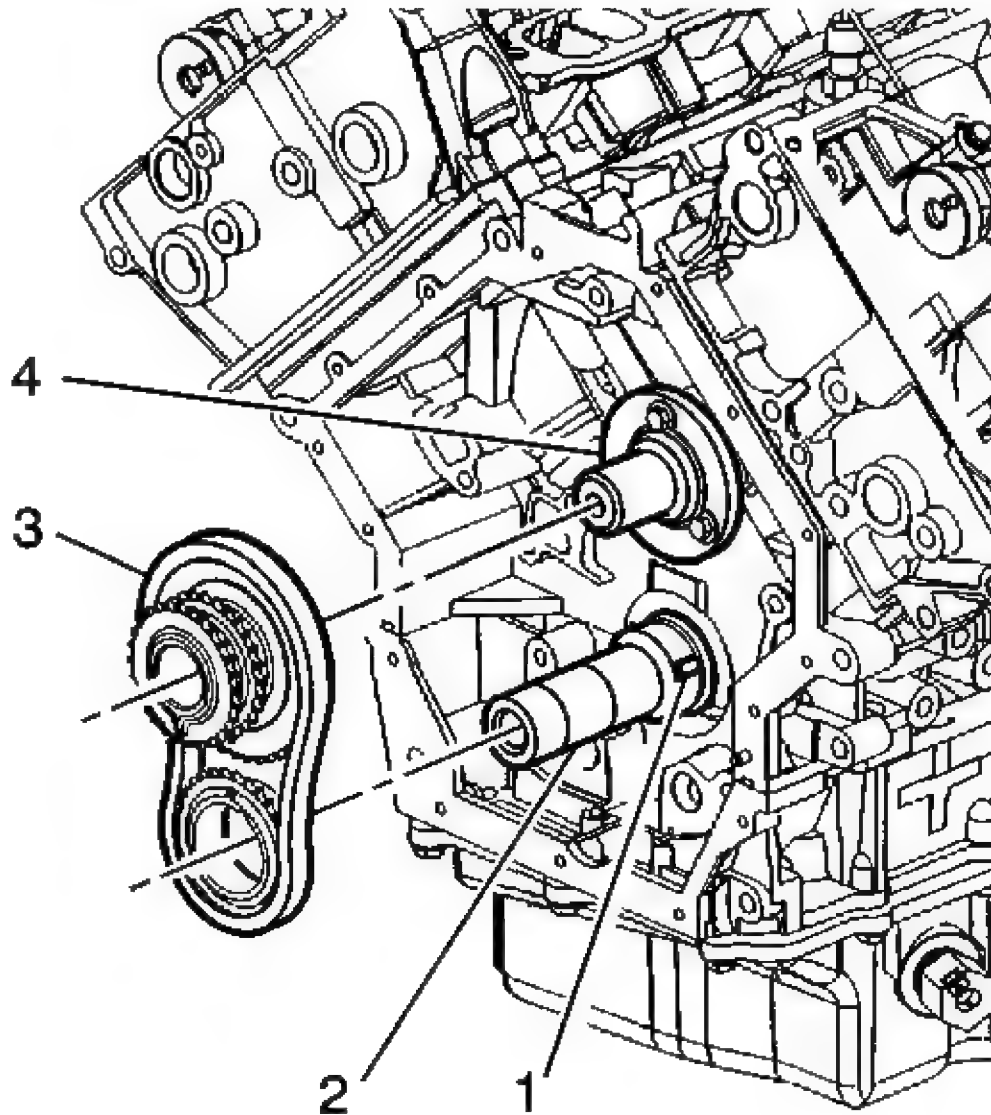


Fig. 33: Identifying Drive Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

3. Ensure the number one piston is at Top Dead Center (TDC) and the crankshaft pin (1) is approximately at the one o'clock position using the **J 39946** . See **Special Tools** .
4. Install the primary camshaft drive chain, camshaft intermediate drive shaft sprocket and

crankshaft sprocket as an assembly (3) onto the camshaft intermediate drive shaft (4) and the crankshaft (2).

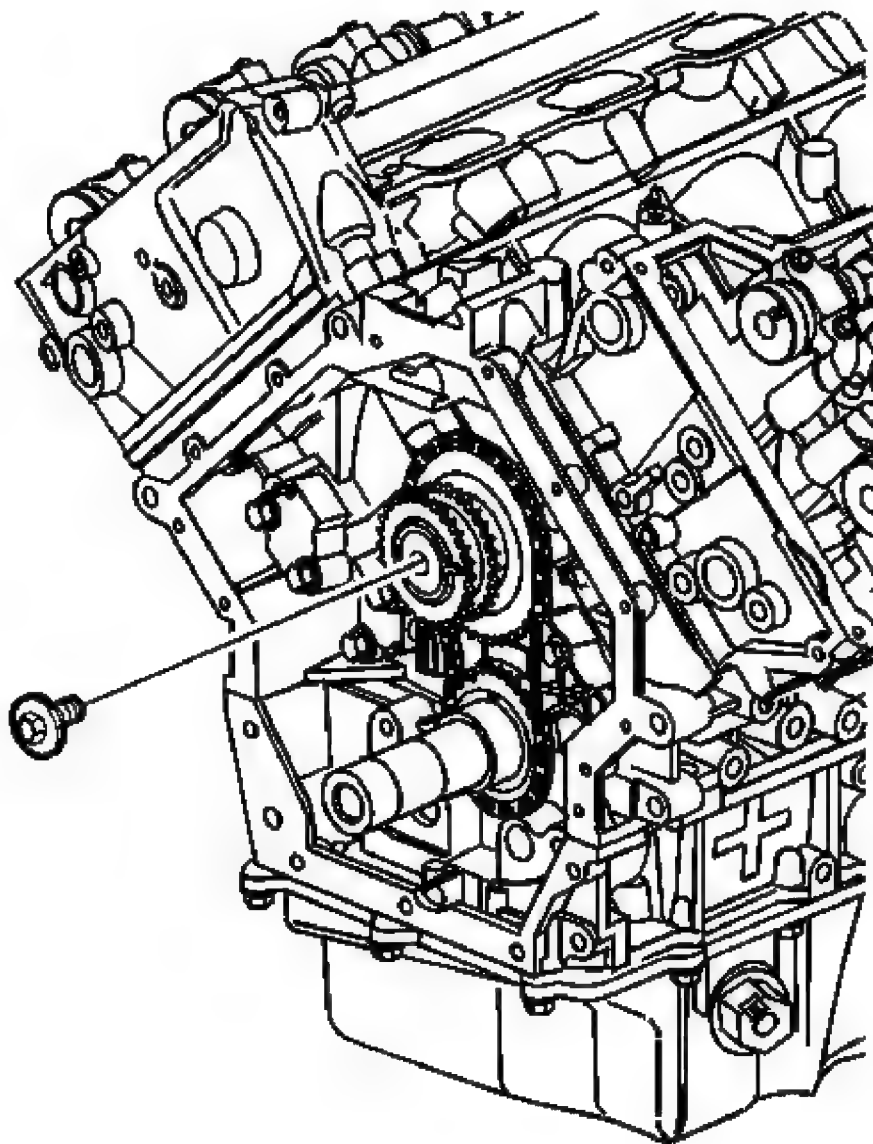


Fig. 34: Identifying Camshaft Intermediate Drive Shaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

5. Install the camshaft intermediate drive shaft sprocket bolt.

Tighten: Tighten the camshaft intermediate drive shaft sprocket bolt to 60 N.m (44 lb ft).

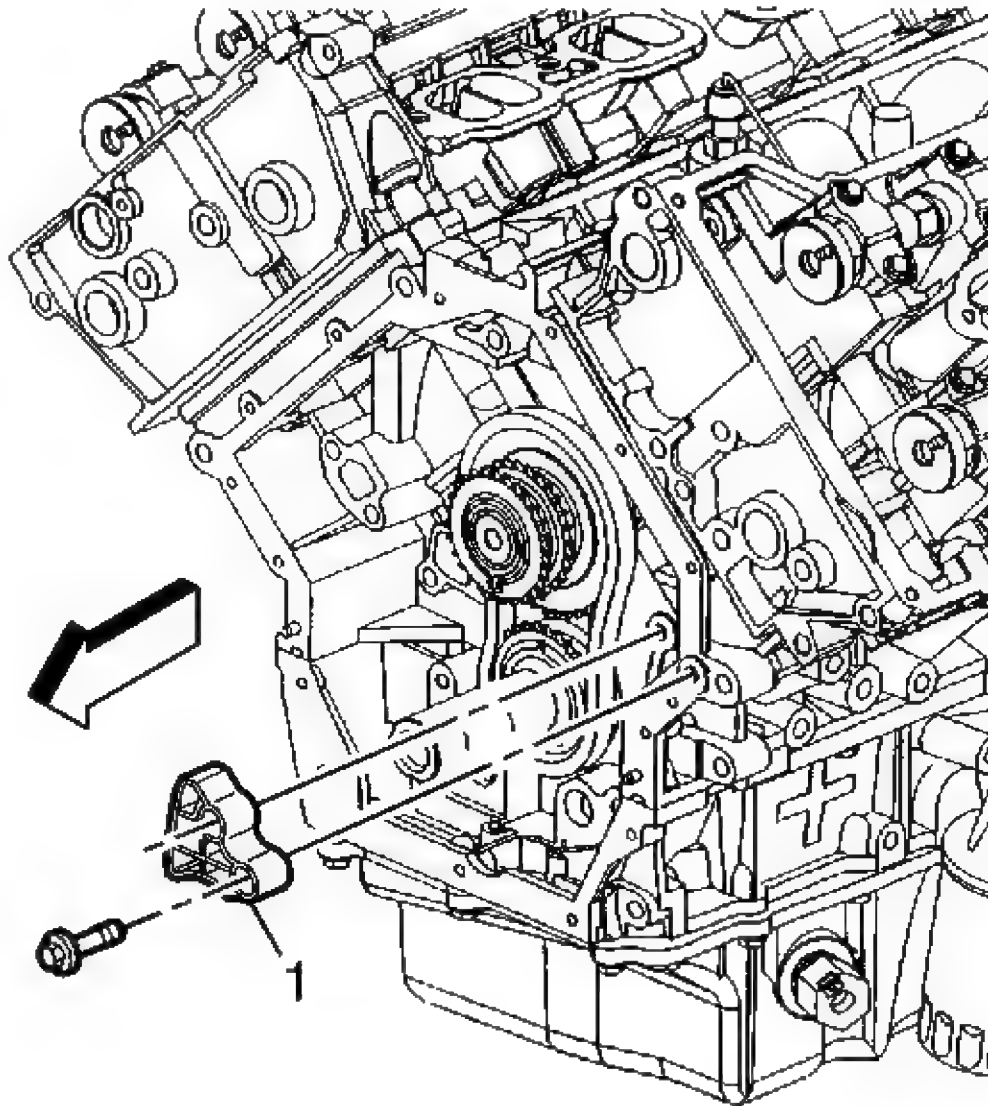


Fig. 35: Locating Primary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the primary camshaft drive chain guide (1).
7. Install the primary camshaft drive chain guide bolts.

Tighten: Tighten the primary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

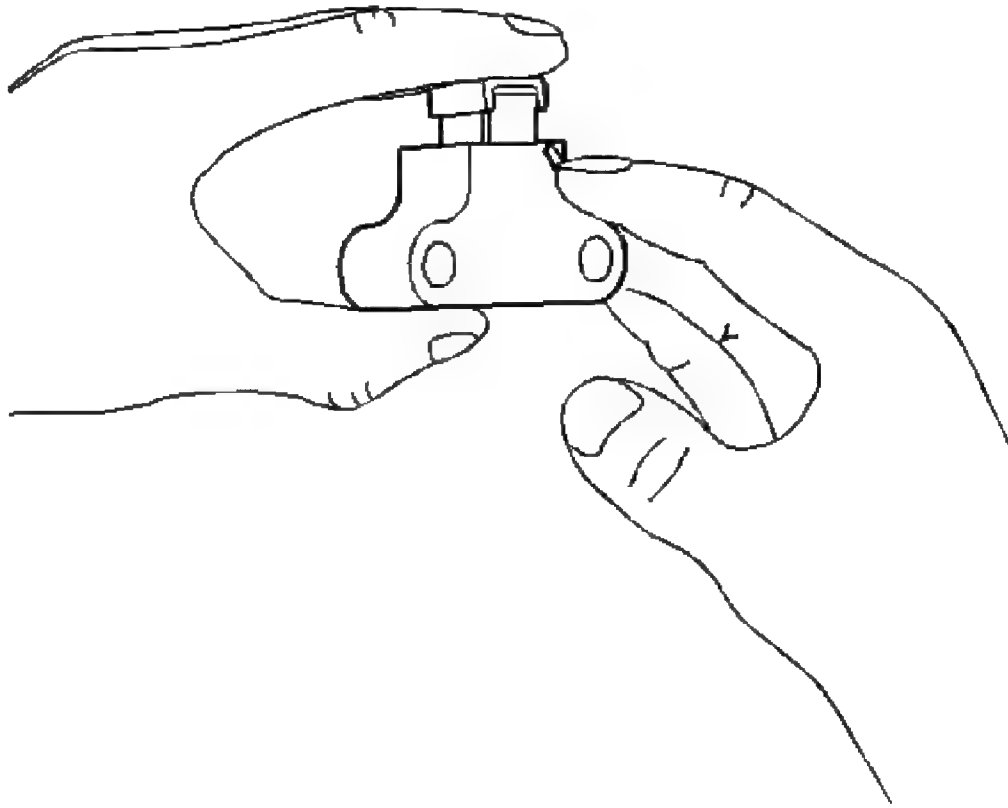


Fig. 36: Collapsing Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

8. Collapse the primary camshaft drive chain tensioner using the following procedure:
 1. Rotate the ratchet release lever counterclockwise and hold.
 2. Collapse the primary camshaft drive chain tensioner shoe and hold.
 3. Release the ratchet lever and slowly release the pressure on the shoe.
9. When the ratchet lever moves to the first detent a click should be heard and felt. Insert a pin through the hole in the release lever in order to lock the primary camshaft drive chain tensioner shoe in the collapsed position.

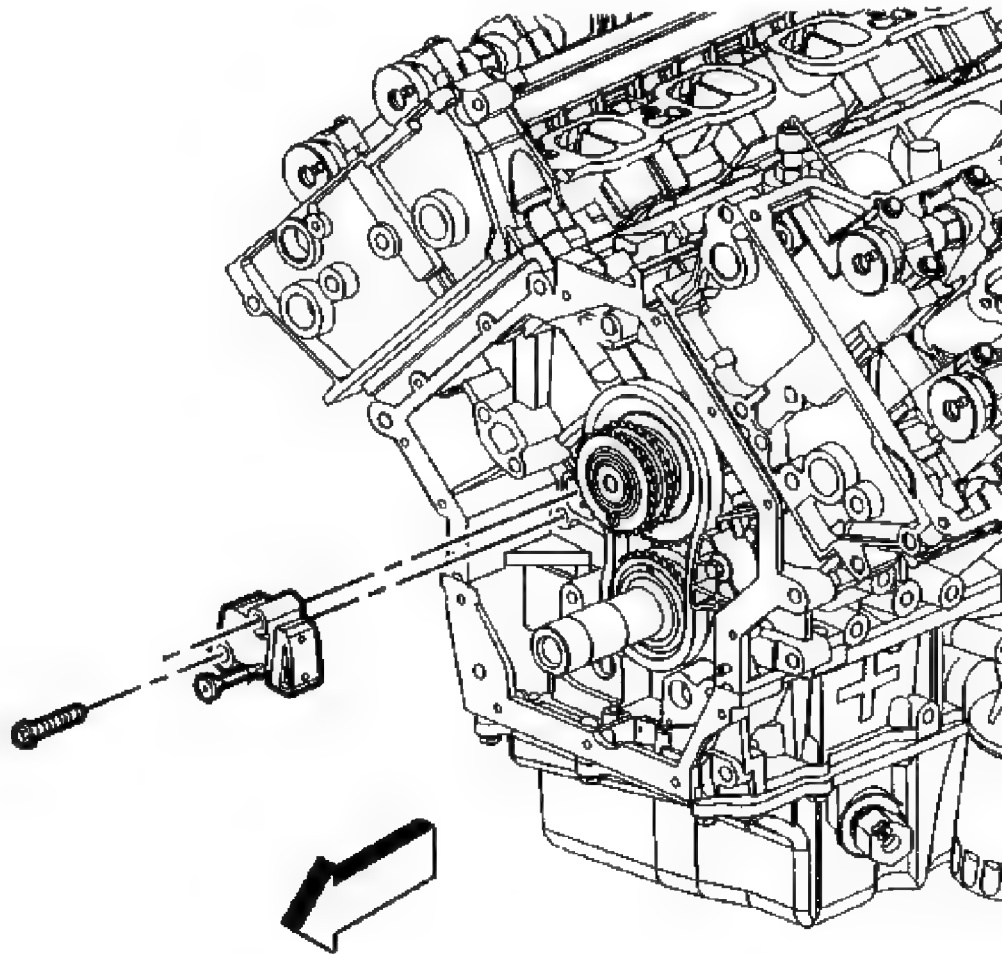


Fig. 37: Identifying Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure the primary camshaft drive chain tensioner release lever is facing out.

10. Install the primary camshaft drive chain tensioner.
11. Install the primary camshaft drive chain tensioner bolts.

Tighten: Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

12. Remove the pin in the release lever locking the primary camshaft drive chain tensioner.

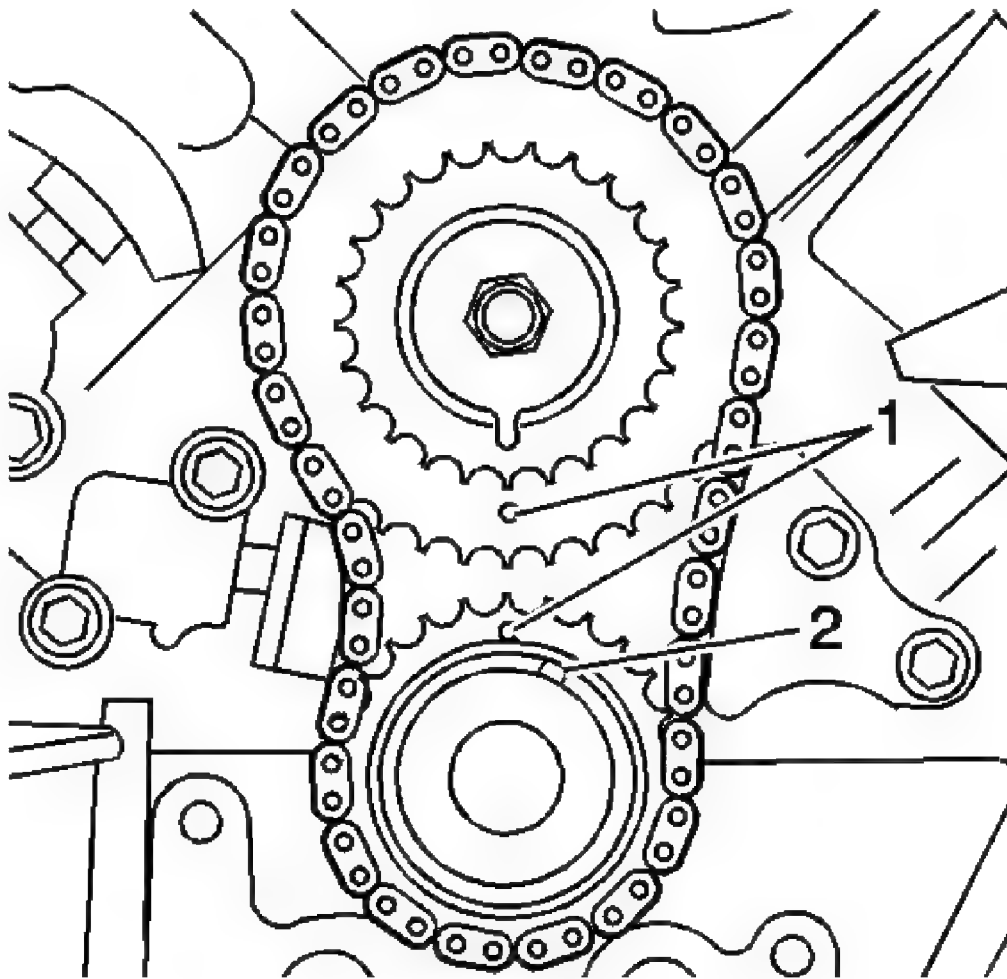


Fig. 38: Ensuring Vertical Timing Mark Alignment
Courtesy of GENERAL MOTORS CORP.

13. Ensure the timing marks (1) are aligned vertically.

SECONDARY CAMSHAFT DRIVE CHAIN INSTALLATION - LEFT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See Special Tools .

INSTALLATION PROCEDURE

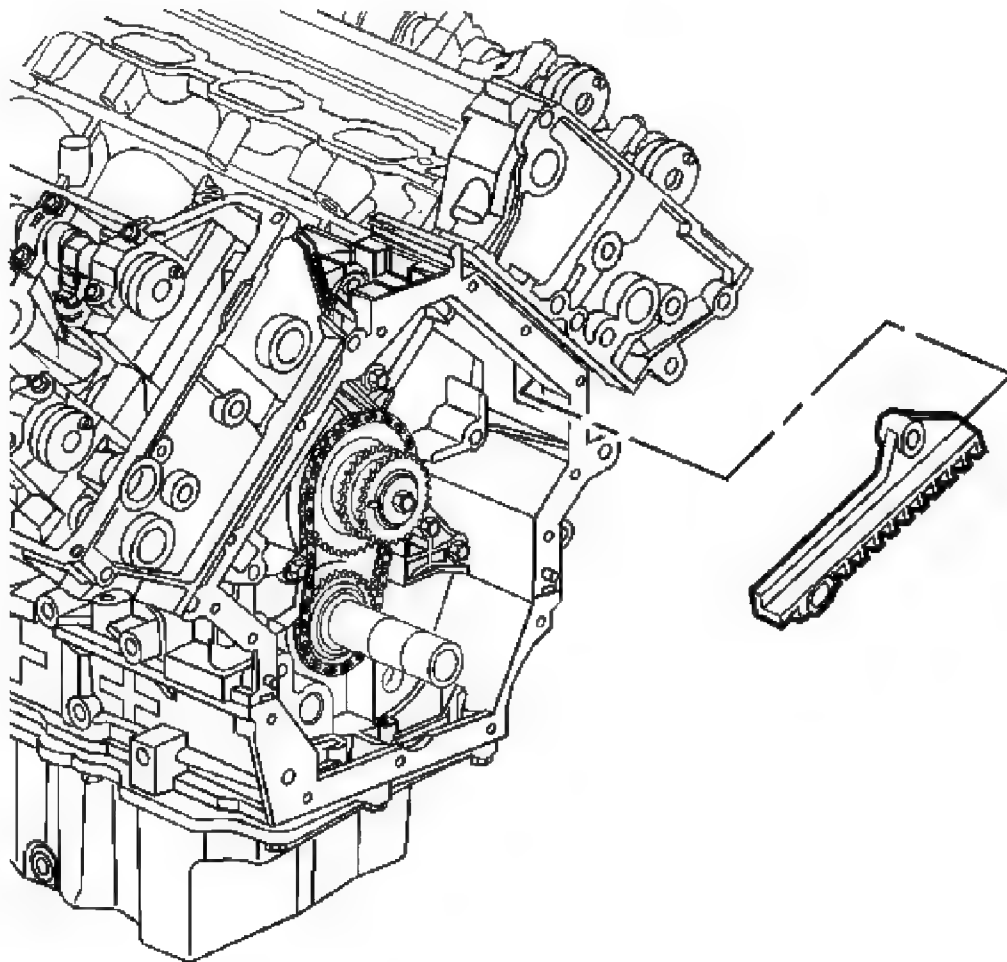


Fig. 39: View Of Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Install the left secondary camshaft drive chain guide.

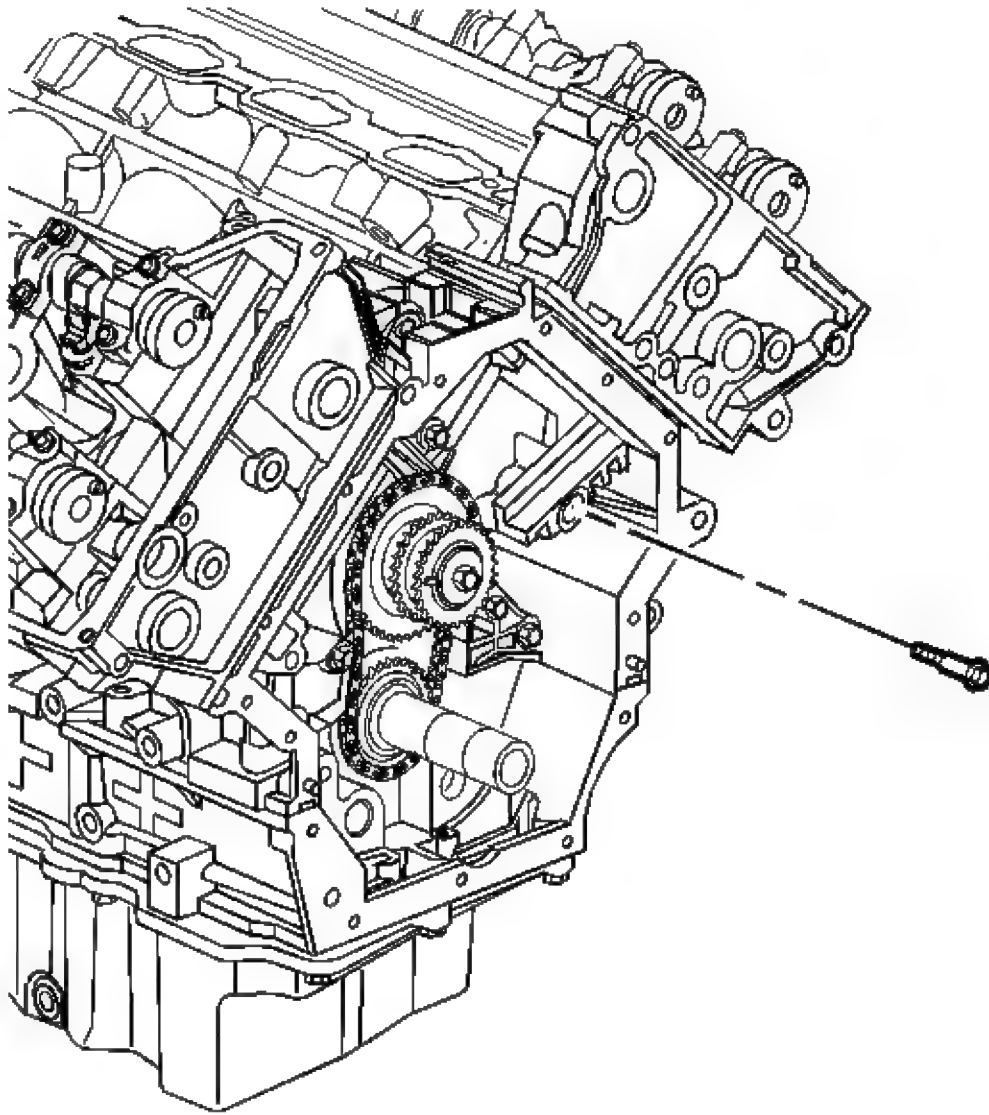


Fig. 40: Identifying Lower Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

2. Loosely install the lower left secondary camshaft drive chain guide bolt.

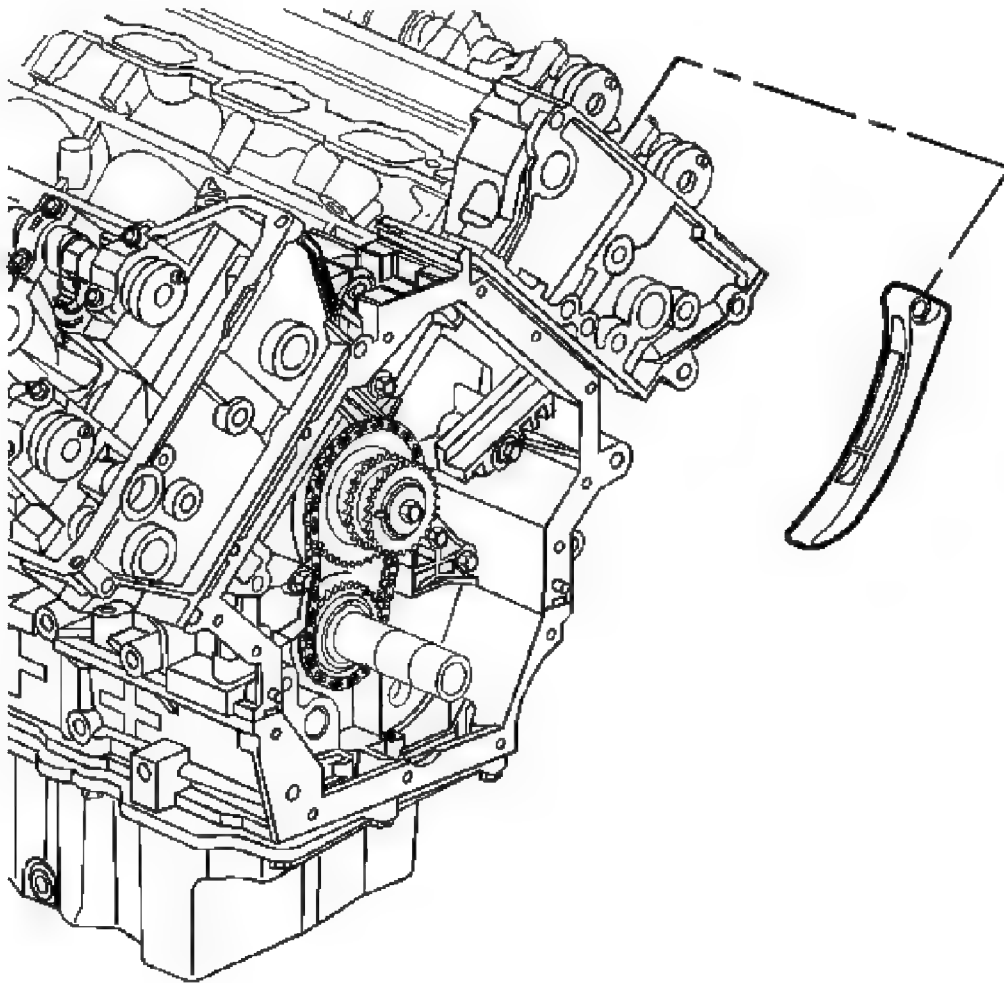


Fig. 41: View of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

3. Install the left secondary camshaft drive chain shoe.

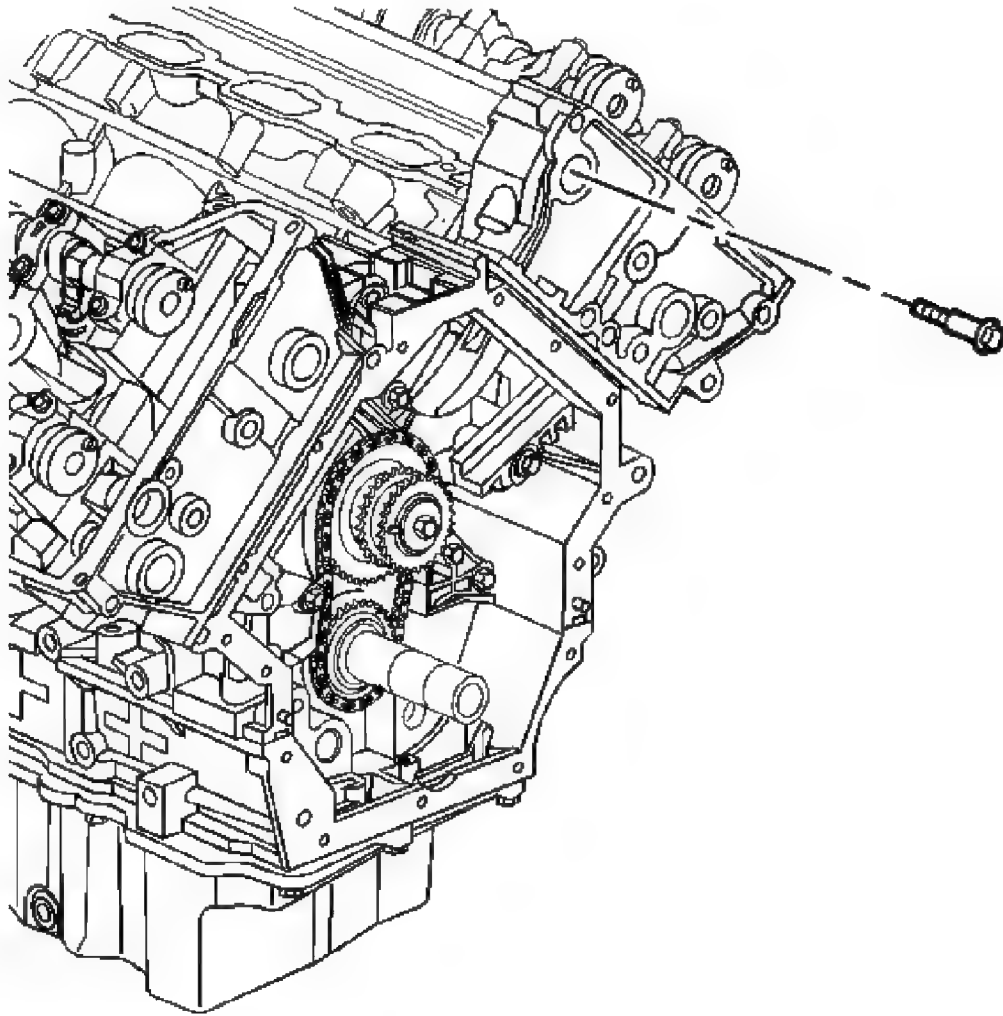


Fig. 42: Identifying Left Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Install the left secondary camshaft drive chain shoe bolt.

Tighten: Tighten the left secondary camshaft drive chain shoe bolt to 25 N.m (18 lb ft).

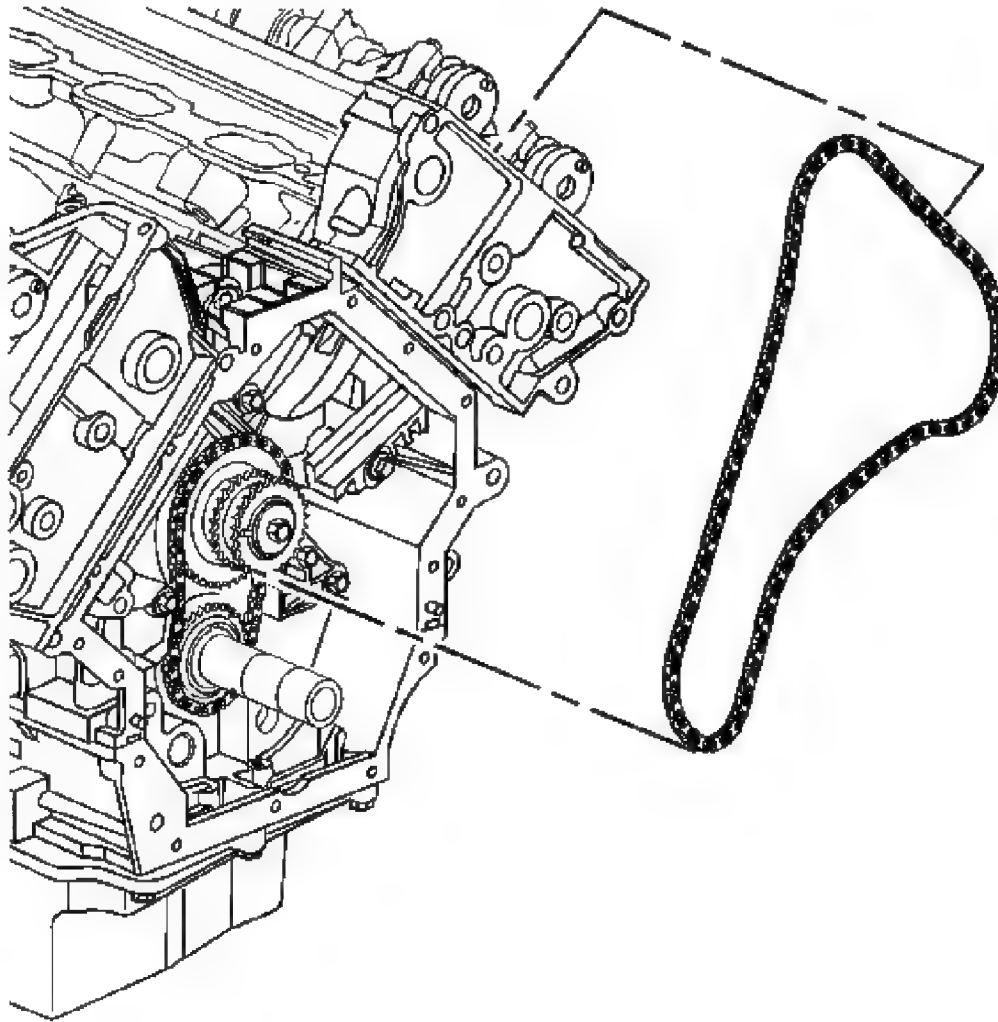


Fig. 43: View of Left Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

5. Install the left secondary camshaft drive chain by sliding the chain down through the left cylinder head and placing the chain on the end of the camshafts.
6. Route the left secondary camshaft drive chain around the inner row of the intermediate drive chain sprocket teeth.

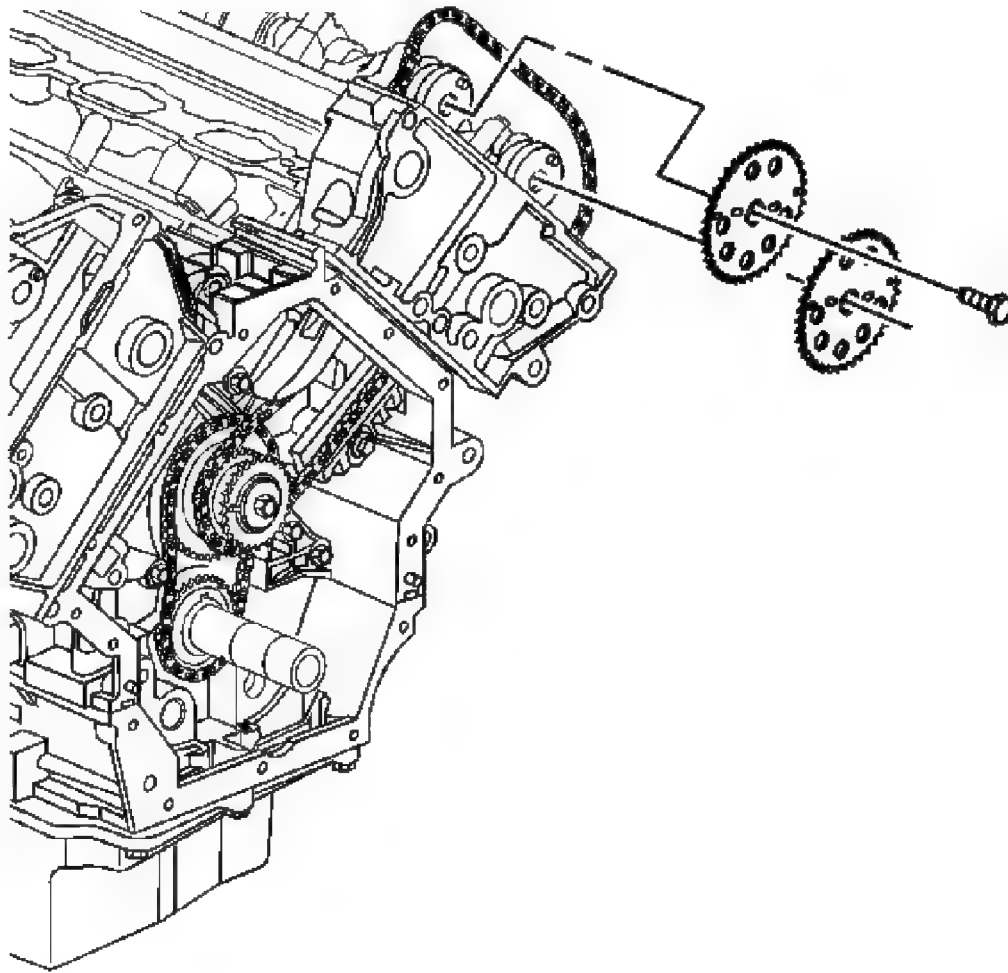


Fig. 44: View Of Left Intake & Exhaust Camshaft Sprockets & Drive Chain
Courtesy of GENERAL MOTORS CORP.

7. Install the left intake and exhaust camshaft sprockets into the left secondary camshaft drive chain.

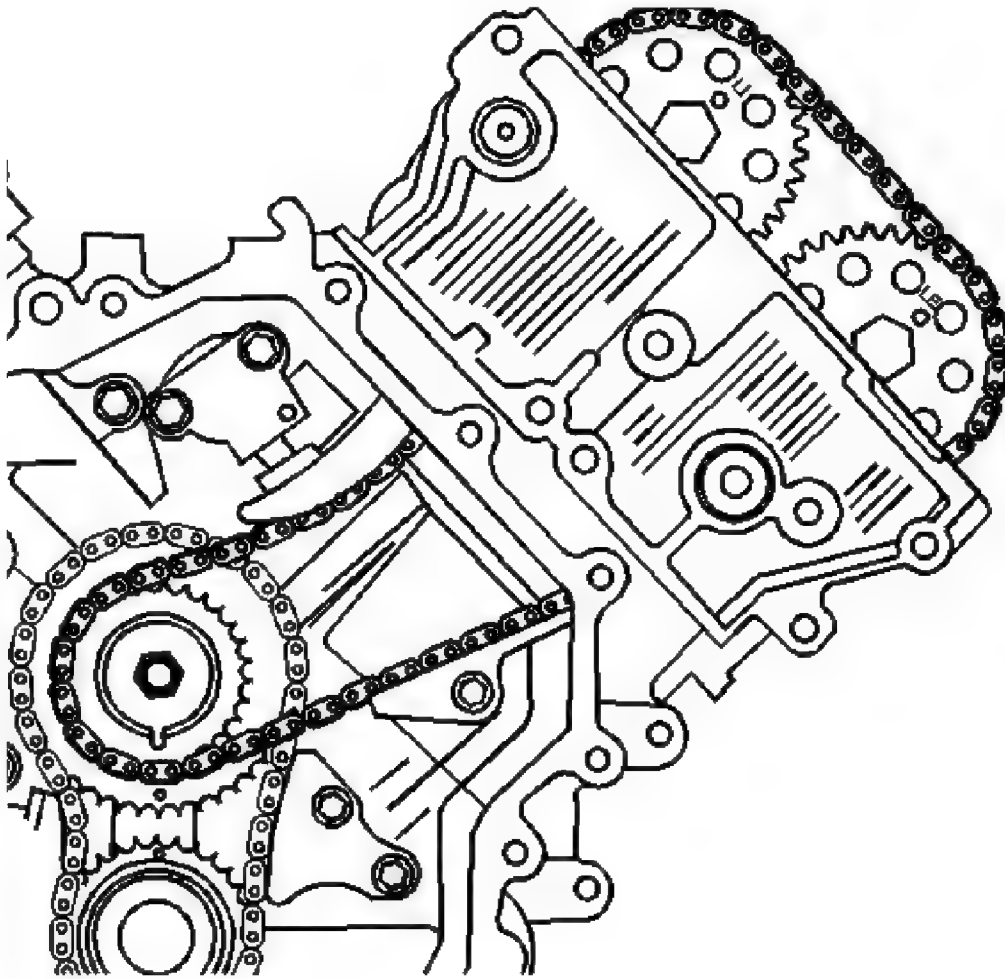


Fig. 45: View of Left Intake & Exhaust Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

8. Install the left intake and exhaust camshaft sprockets onto the camshafts. The camshaft sprocket notch marked "LI" which indicates left intake, engages the intake camshaft pin and the camshaft sprocket notch marked "LE" which indicates left exhaust, engages the exhaust camshaft pin.

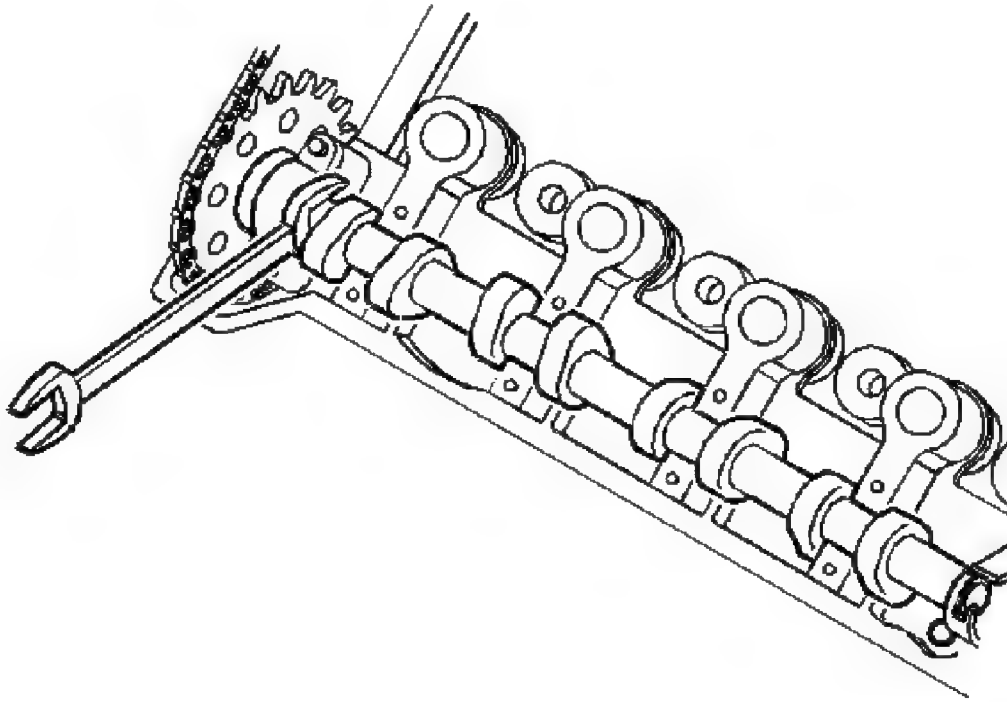


Fig. 46: Aligning Sprocket Notch-To-Camshaft Pin
Courtesy of GENERAL MOTORS CORP.

9. If necessary, use an open wrench on the hex cast near the front of each camshaft to help align the sprocket notch to the camshaft pin.
10. Loosely install the left intake and exhaust camshaft sprocket bolts.

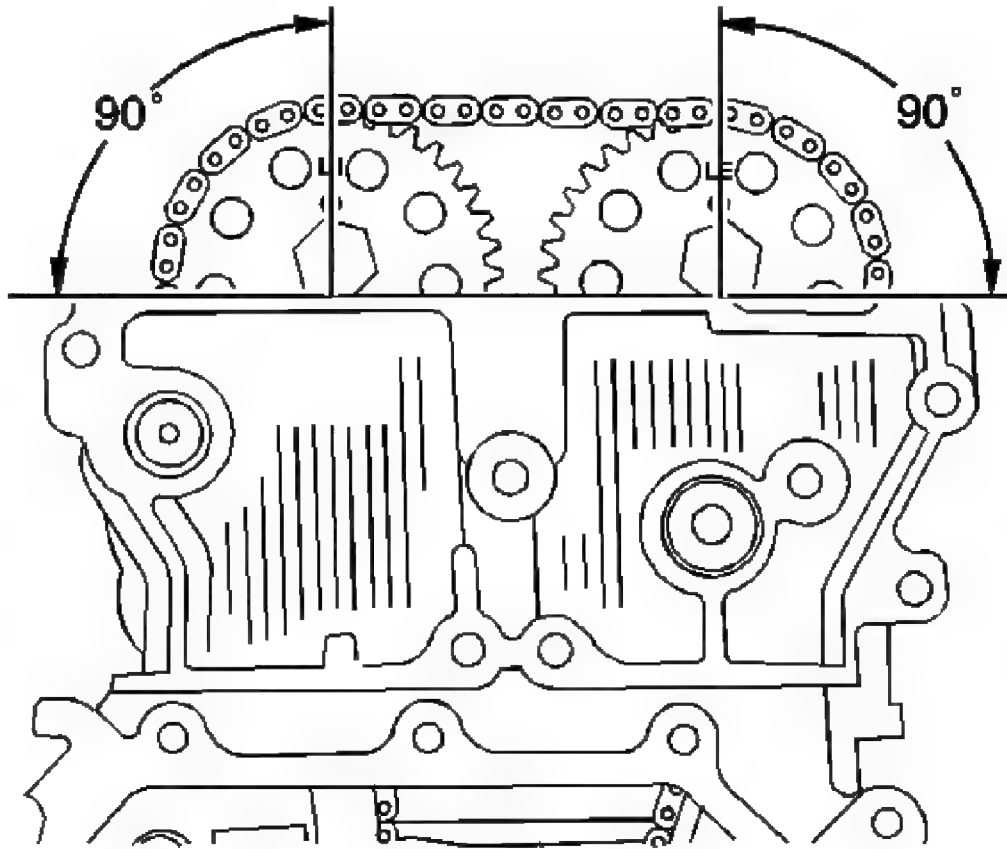


Fig. 47: Ensuring Camshaft Sprocket Drive Pins Are At The Top Of Their Rotation

Courtesy of GENERAL MOTORS CORP.

11. Ensure the perpendicular alignment of the left intake and exhaust camshaft sprocket notches and camshaft pins to the cylinder head.

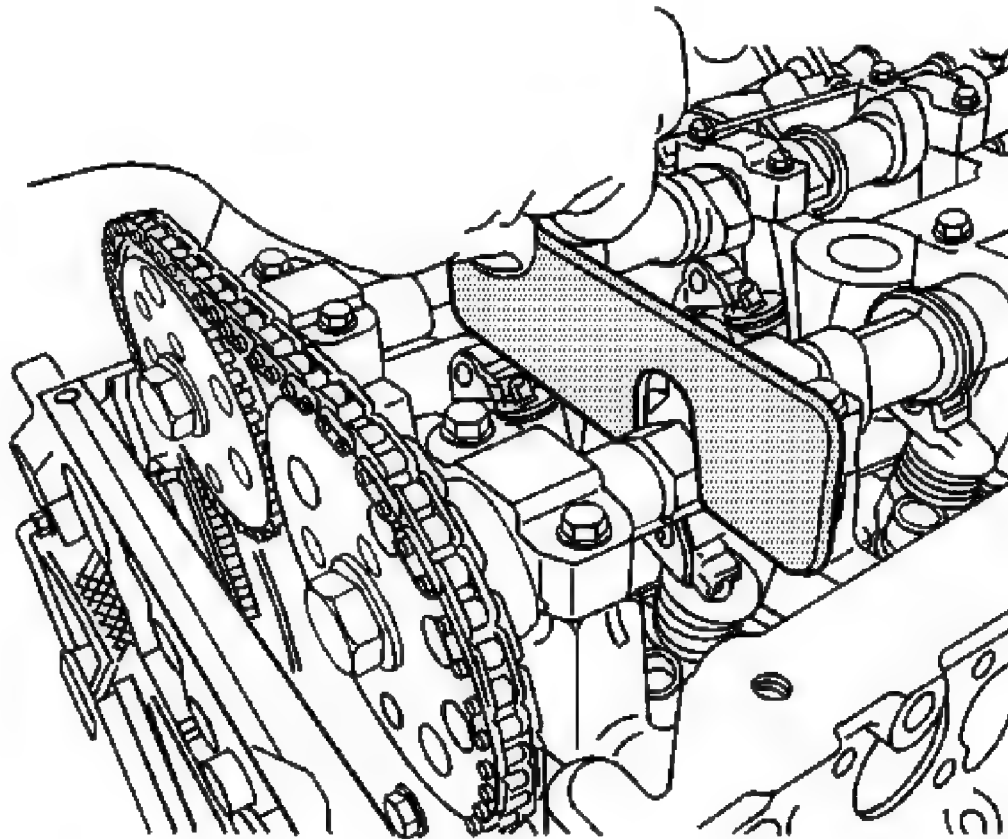


Fig. 48: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

12. Install the **J 44212** to the left cylinder head camshafts. See **Special Tools** .

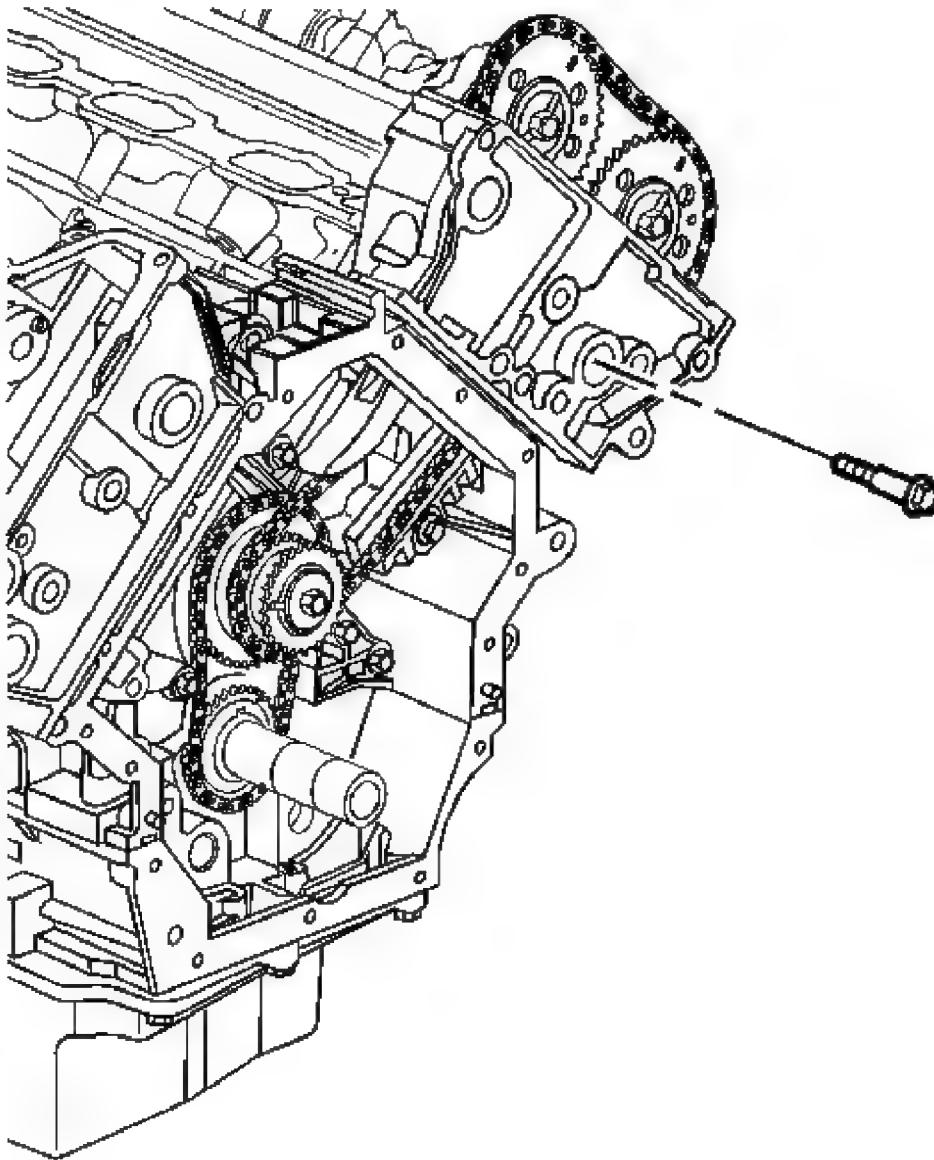


Fig. 49: Identifying Upper Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

13. Install the upper left secondary camshaft drive chain guide bolt.

Tighten: Tighten BOTH the upper and lower left secondary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

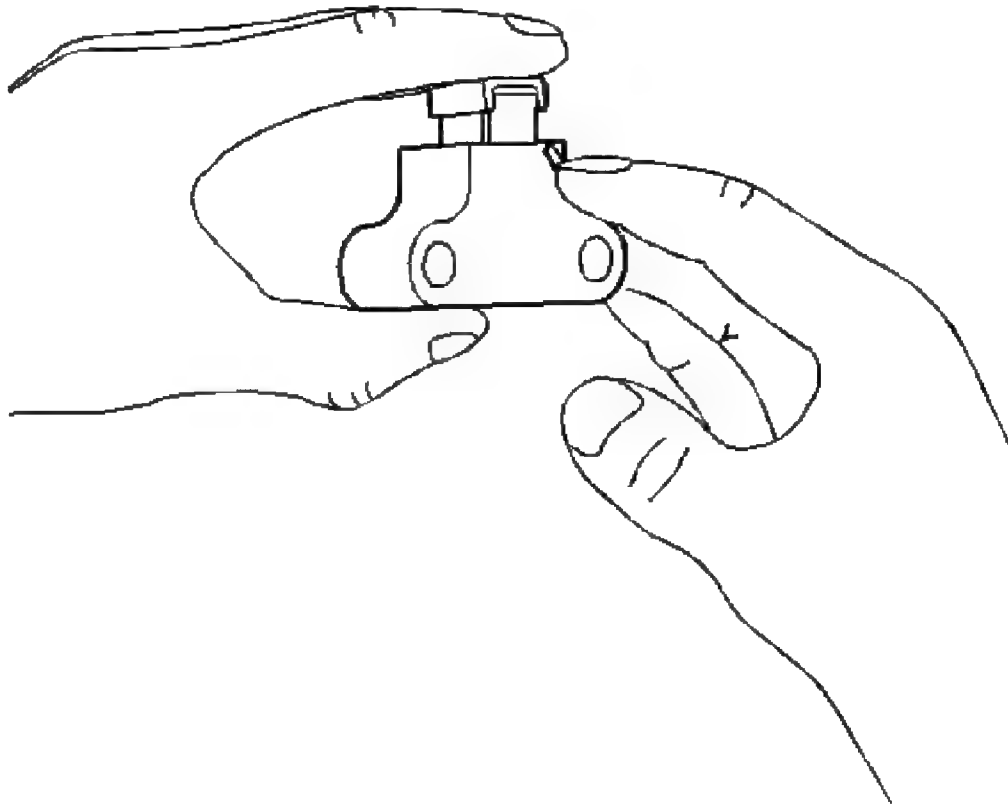


Fig. 50: Collapsing Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

14. Collapse the left secondary camshaft drive chain tensioner using the following procedure:
 1. Rotate the ratchet release lever counterclockwise and hold.
 2. Collapse the left secondary camshaft drive chain tensioner shoe and hold.
 3. Release the ratchet lever and slowly release the pressure on the shoe.
15. When the ratchet lever moves to the first detent a click should be heard and felt. Insert a pin through the hole in the release lever in order to lock the left secondary camshaft drive chain tensioner shoe in the collapsed position.

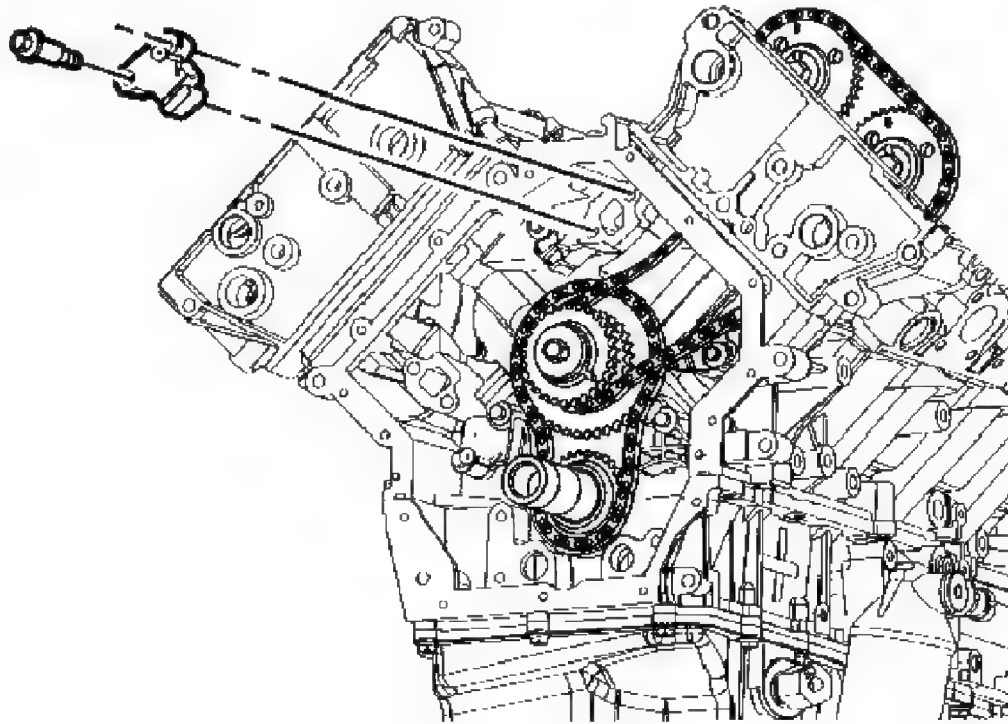


Fig. 51: View Of Left Secondary Camshaft Drive Chain Tensioner Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure the left secondary camshaft drive chain tensioner release lever is facing out.

16. Install the left secondary camshaft drive chain tensioner.
17. Install the left secondary camshaft drive chain tensioner bolts.

Tighten: Tighten the left secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

18. Remove pin from left secondary camshaft drive chain tensioner lever.

SECONDARY CAMSHAFT DRIVE CHAIN INSTALLATION - RIGHT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See Special Tools .

INSTALLATION PROCEDURE

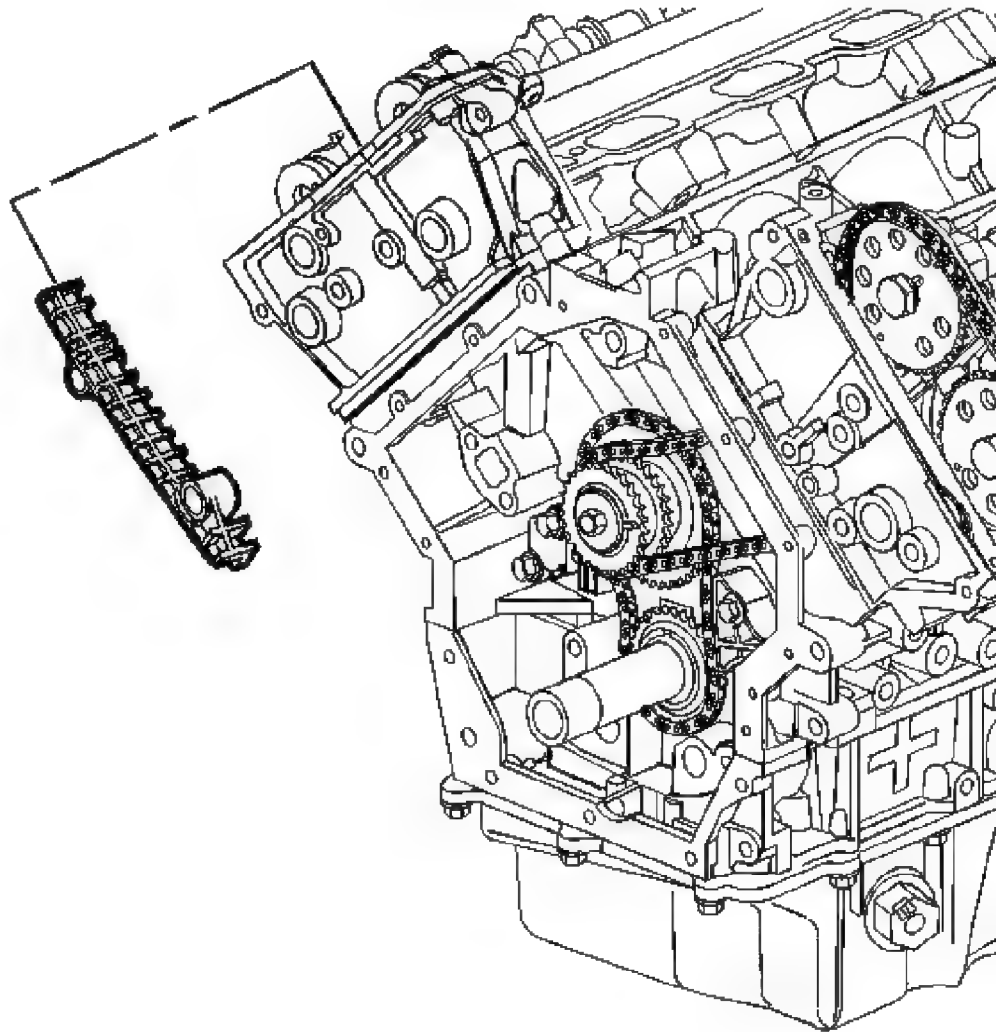


Fig. 52: View of Right Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Install the right secondary camshaft drive chain guide.

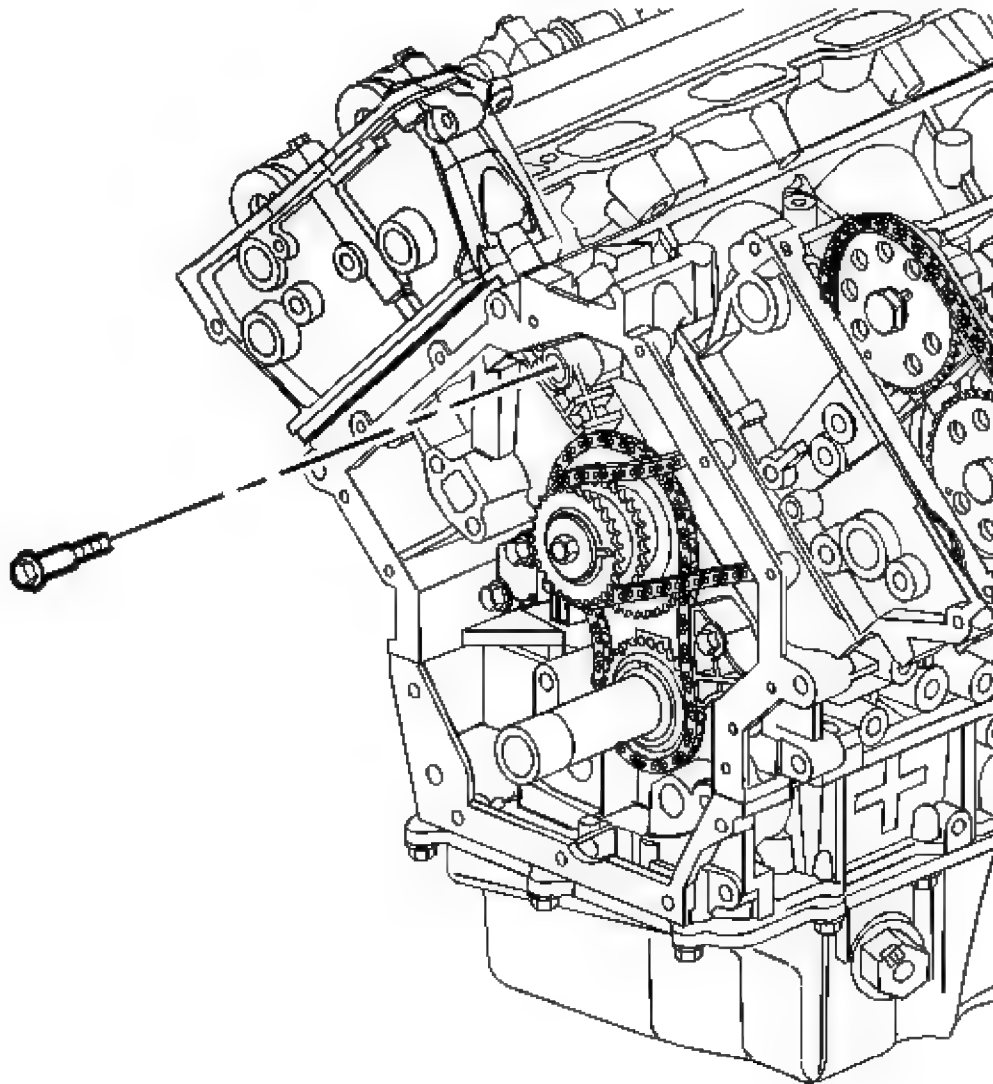


Fig. 53: Identifying Lower Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

2. Loosely install the lower right secondary camshaft drive chain guide bolt.

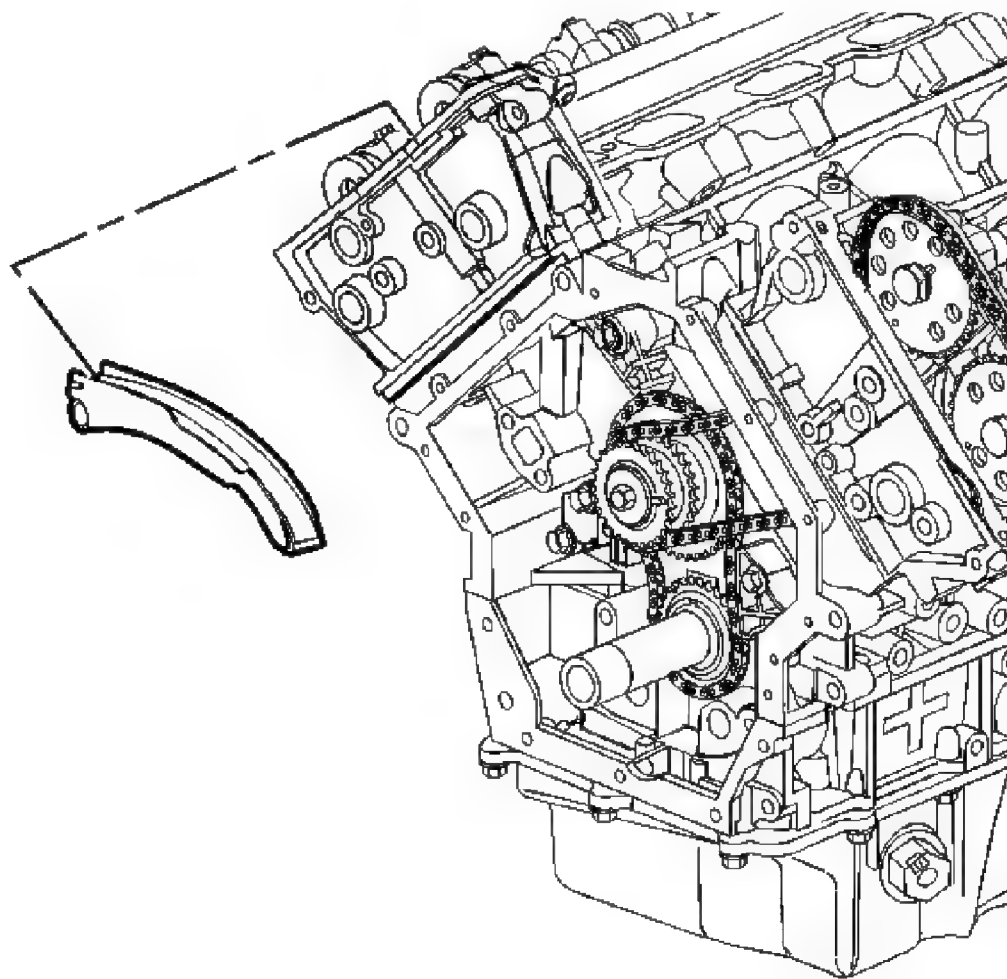


Fig. 54: View of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

3. Install the right secondary camshaft drive chain shoe.

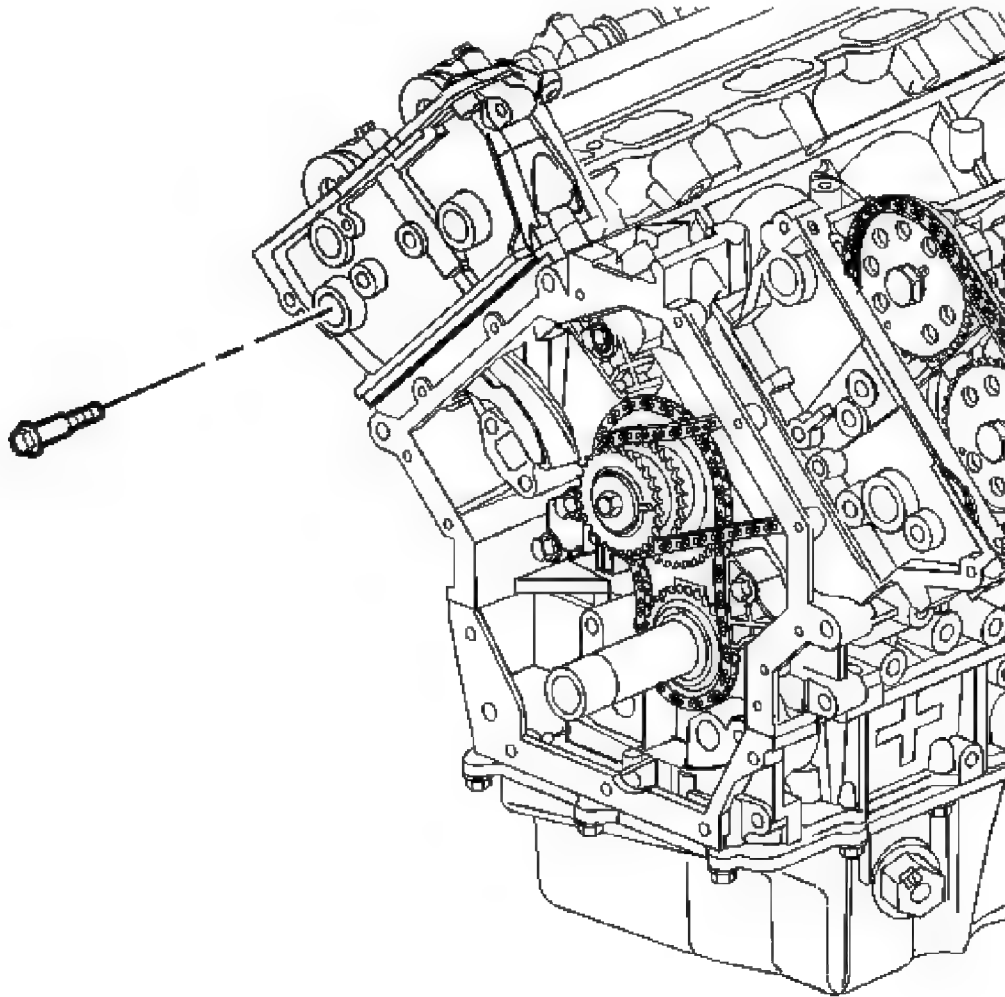


Fig. 55: Identifying Right Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Install the right secondary camshaft drive chain shoe bolt.

Tighten: Tighten the right secondary camshaft drive chain shoe bolt to 25 N.m (18 lb ft).

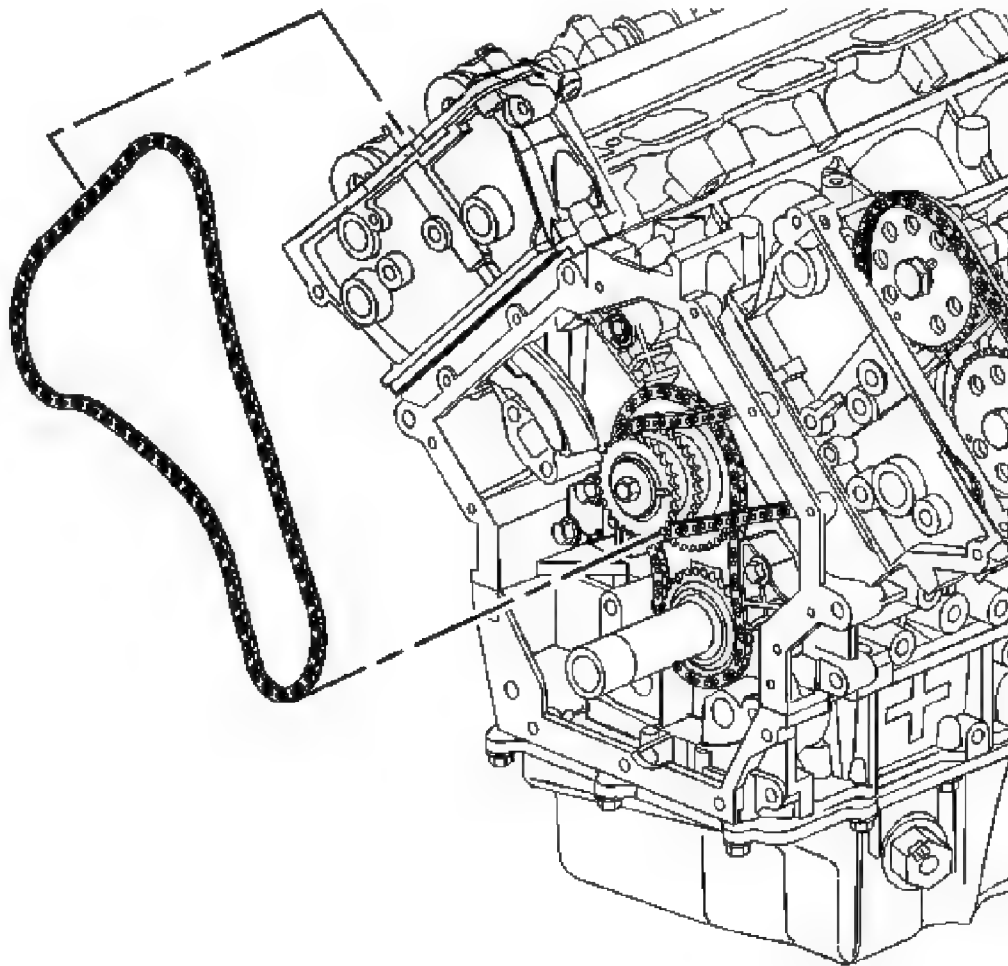


Fig. 56: View of Right Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

5. Install the right secondary camshaft drive chain by sliding the chain down through the right cylinder head and placing the chain on the end of the camshafts.
6. Route the right secondary camshaft drive chain around the outer row of the intermediate drive chain sprocket teeth.

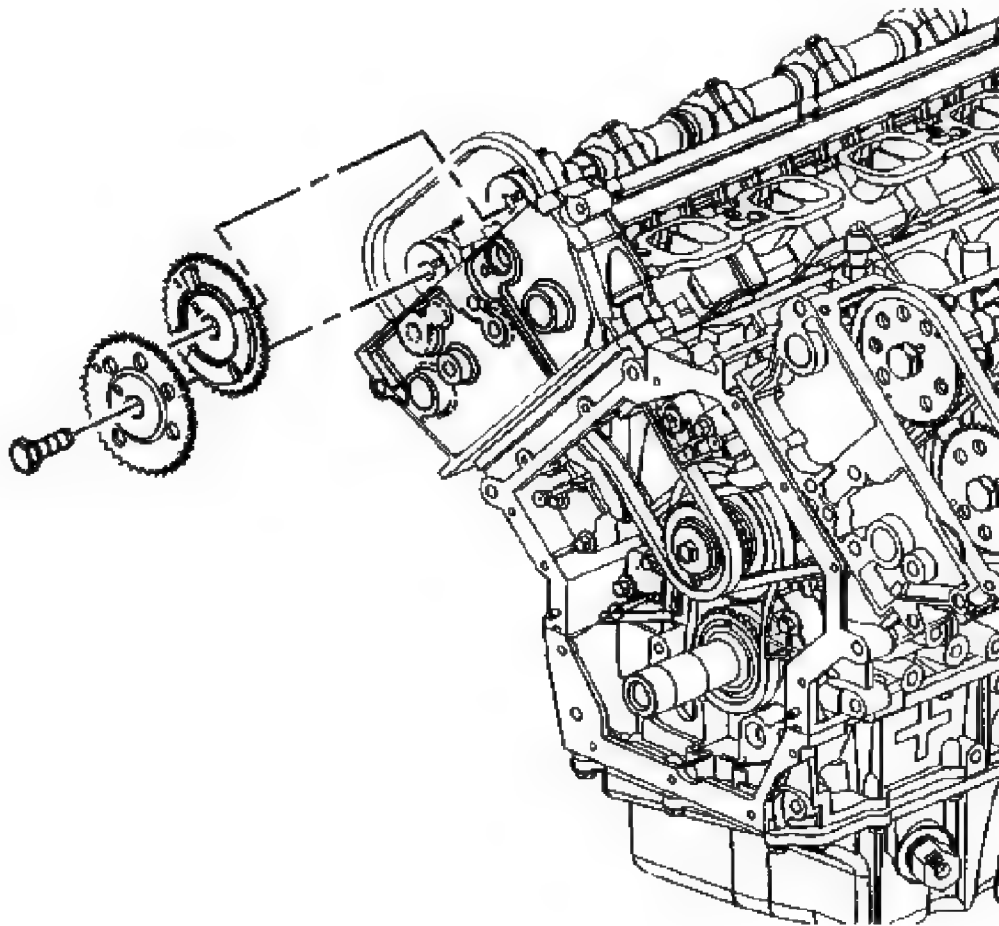


Fig. 57: Identifying Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

7. Install the right intake and exhaust camshaft sprockets into the right secondary camshaft drive chain.

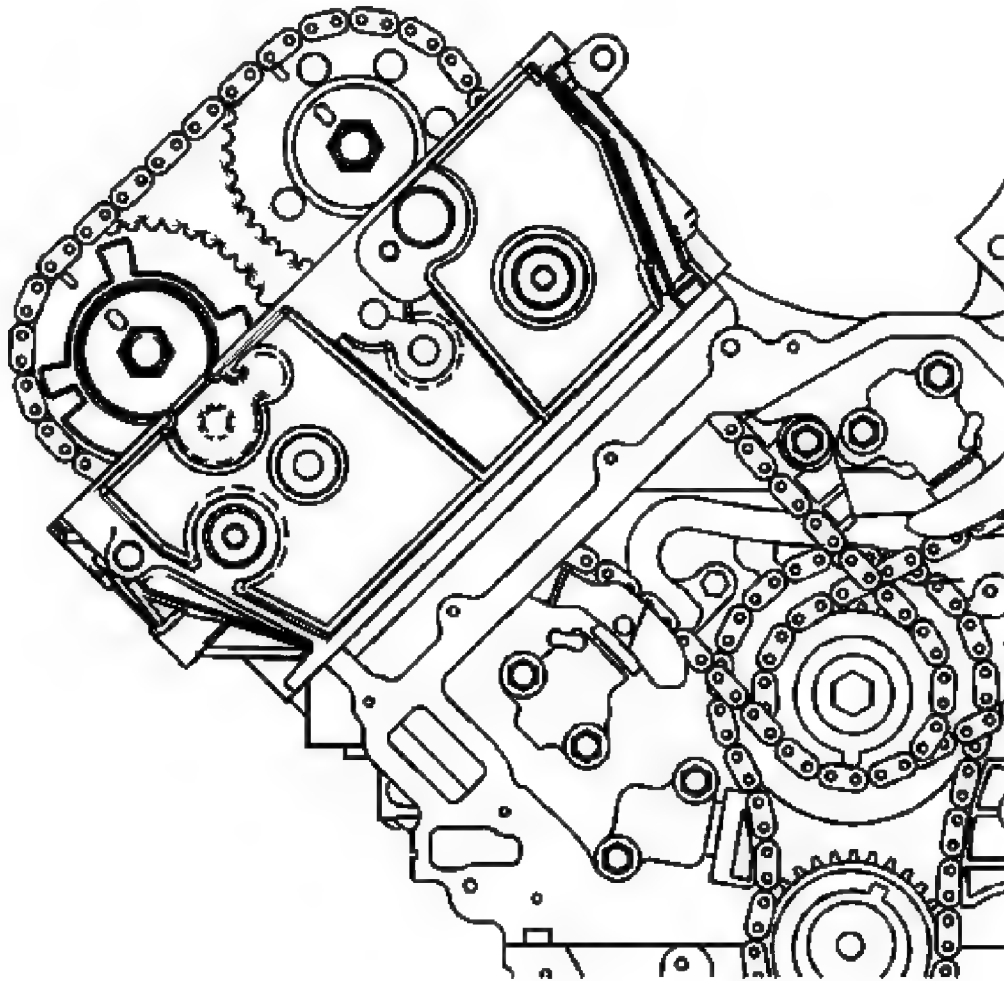


Fig. 58: View Of Right Intake & Exhaust Camshafts Sprockets
Courtesy of GENERAL MOTORS CORP.

8. Install the right intake and exhaust camshafts sprockets onto the camshafts. The camshaft sprocket notch marked "RI" which indicates right intake, engages the intake camshaft pin and the camshaft sprocket notch marked "RE" which indicates right exhaust, engages the exhaust camshaft pin.

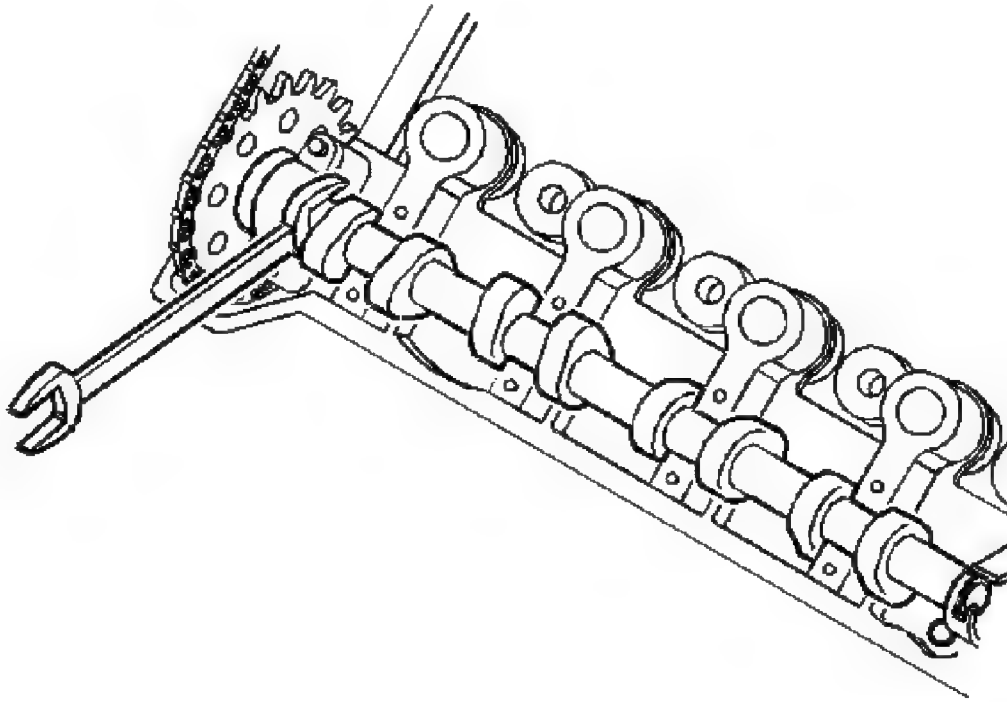


Fig. 59: Aligning Sprocket Notch-To-Camshaft Pin
Courtesy of GENERAL MOTORS CORP.

9. If necessary, use an open wrench on the hex cast near the front of each camshaft to help align the sprocket notch to the camshaft pin.
10. Loosely install the right intake and exhaust camshaft sprocket bolts.

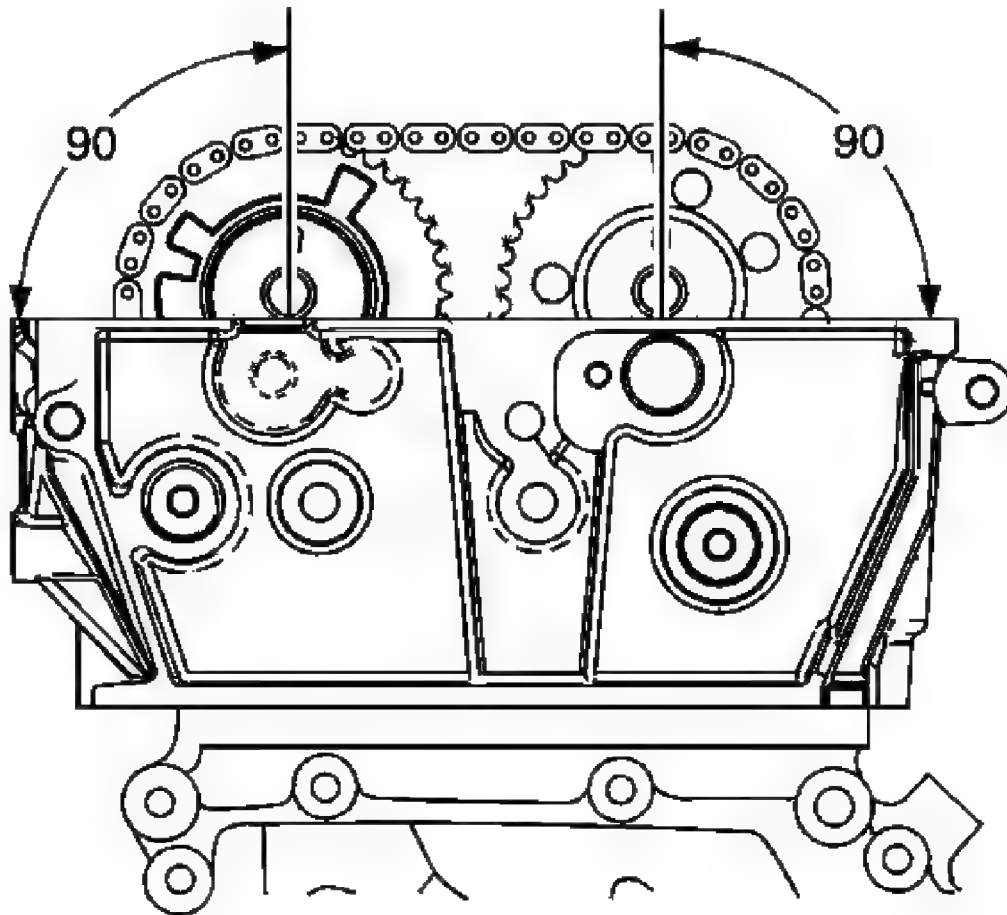


Fig. 60: Aligning Right Intake & Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

11. Ensure the perpendicular alignment of the right intake and exhaust camshaft sprocket notches and camshaft pins to the cylinder head.

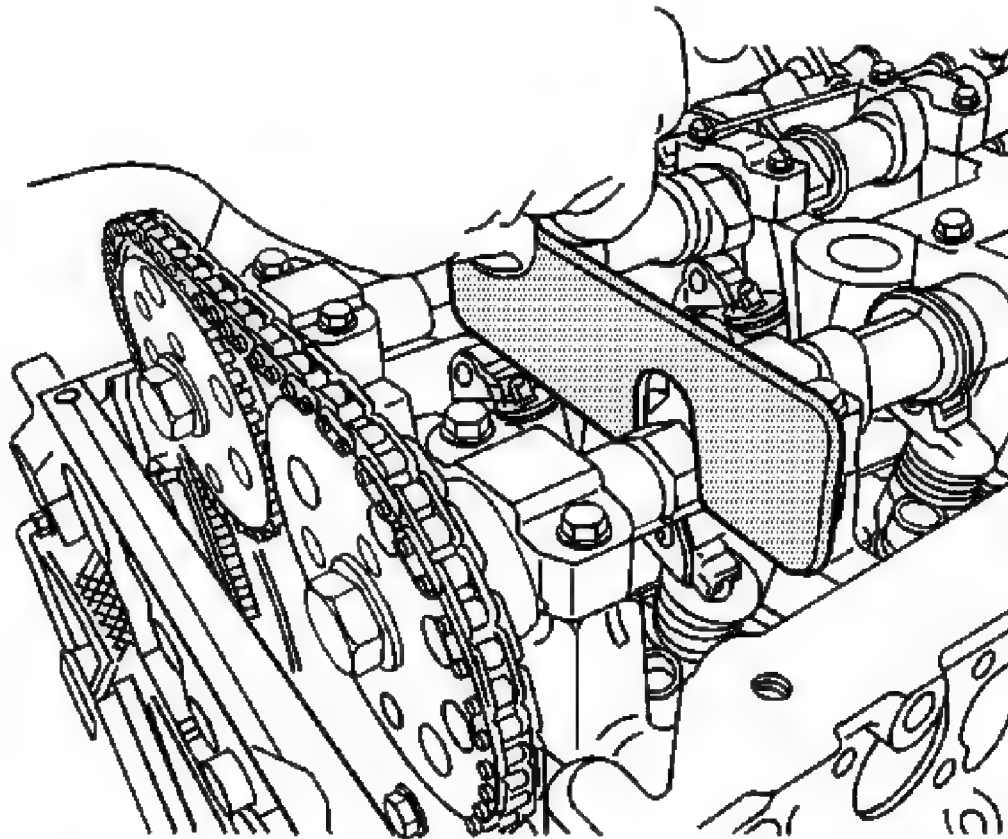


Fig. 61: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

12. Install the **J 44212** to the right cylinder head camshafts. See **Special Tools** .

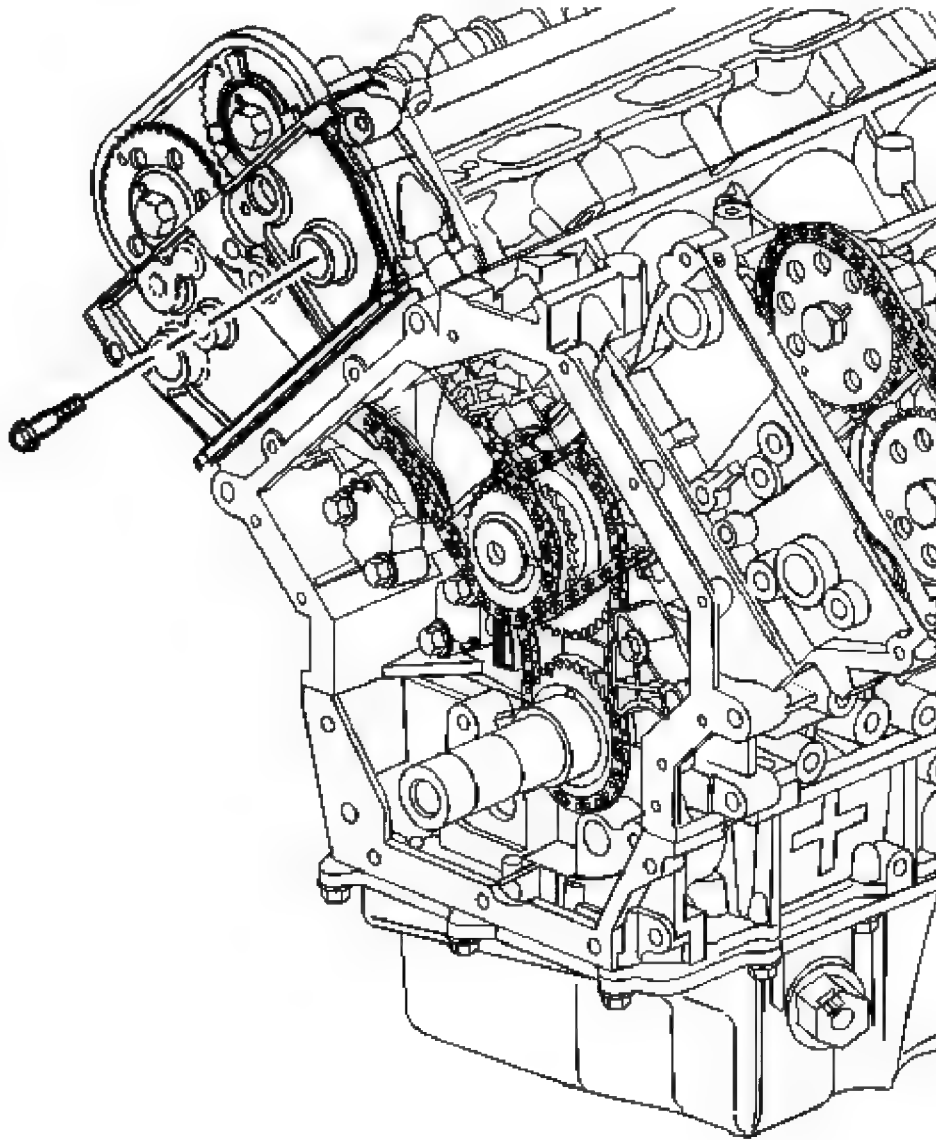


Fig. 62: View Of Upper Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

13. Install the upper right secondary camshaft drive chain guide bolt.

Tighten: Tighten BOTH the upper and lower right secondary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

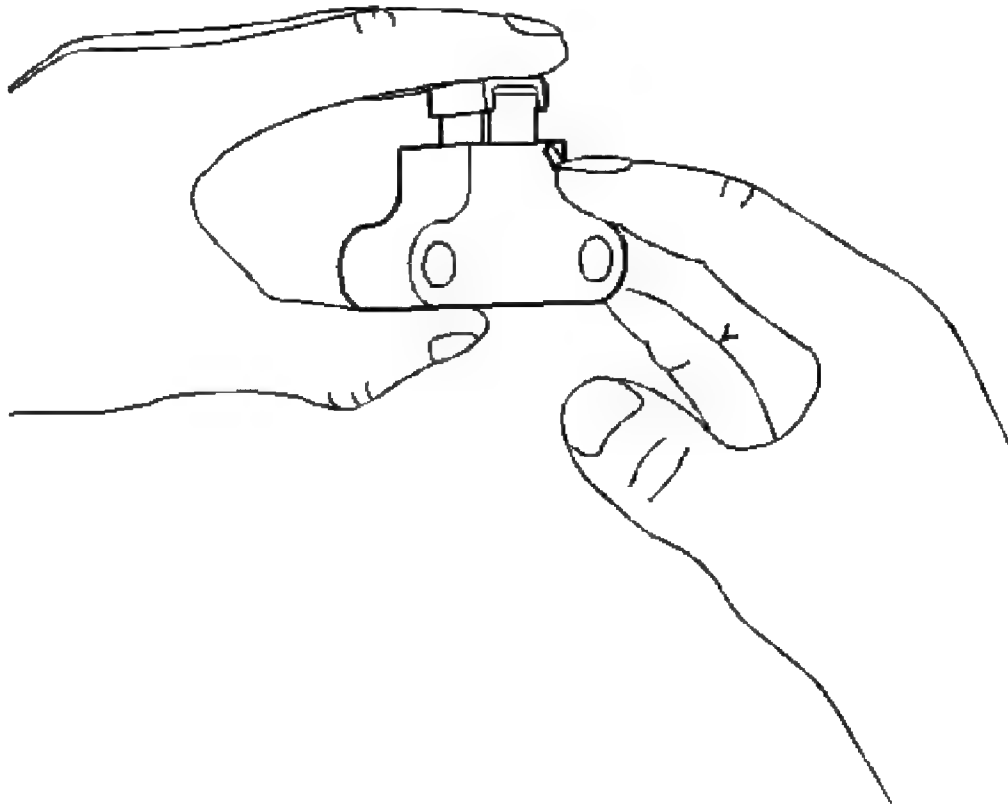


Fig. 63: Collapsing Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

14. Collapse the right secondary camshaft drive chain tensioner using the following procedure:
 1. Rotate the ratchet release lever counter-clockwise and hold.
 2. Collapse the right secondary camshaft drive chain tensioner shoe and hold.
 3. Release the ratchet lever and slowly release the pressure on the shoe.
15. When the ratchet lever moves to the first detent a click should be heard and felt. Insert a pin through the hole in the release lever in order to lock the right secondary camshaft drive chain tensioner shoe in the collapsed position.

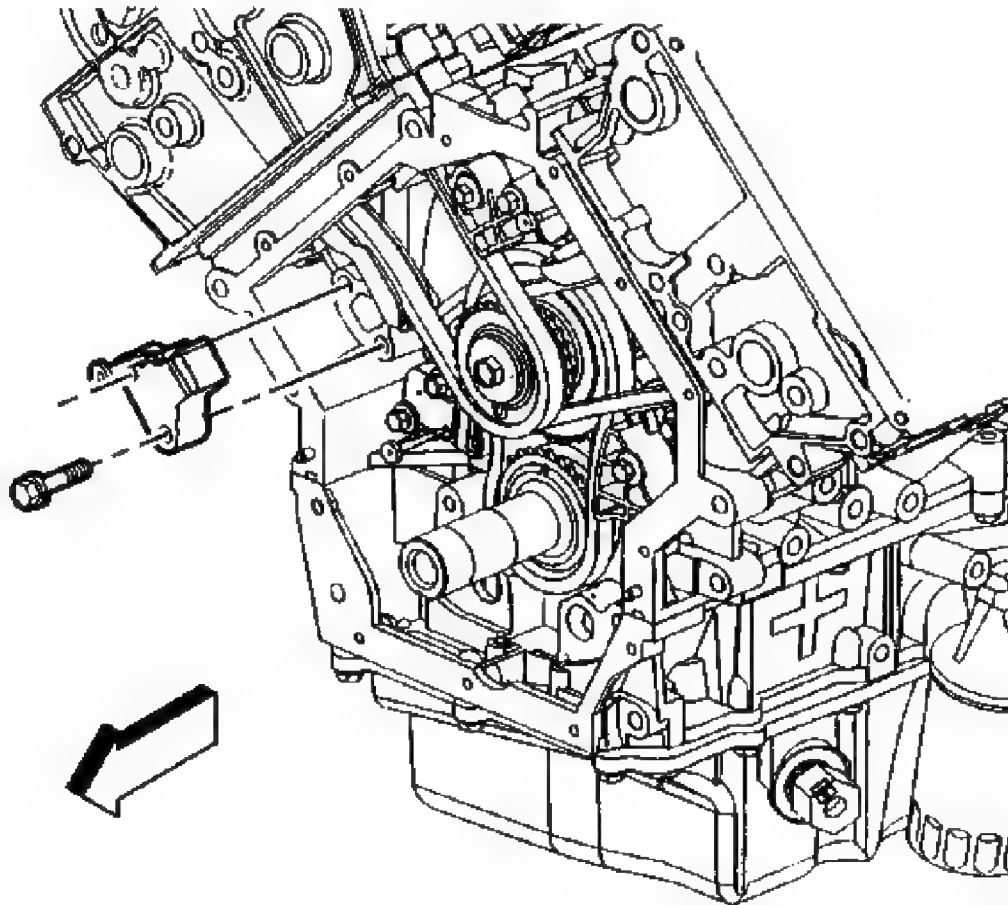


Fig. 64: View Of Right Secondary Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure the right secondary camshaft drive chain tensioner release lever is facing out.

16. Install the right secondary camshaft drive chain tensioner.
17. Install the right secondary camshaft drive chain tensioner bolts.

Tighten: Tighten the right secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

18. Remove pin from right secondary camshaft drive chain tensioner lever.

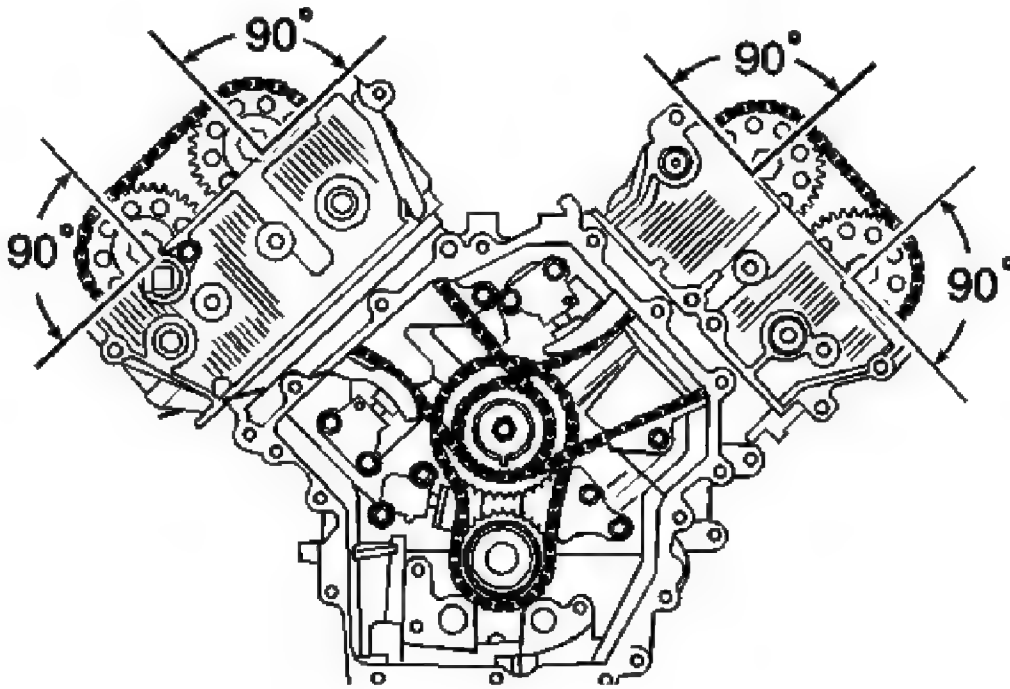


Fig. 65: Ensuring Correct Alignment Of Secondary Timing Components
Courtesy of GENERAL MOTORS CORP.

19. Ensure the correct alignment of all secondary timing components.

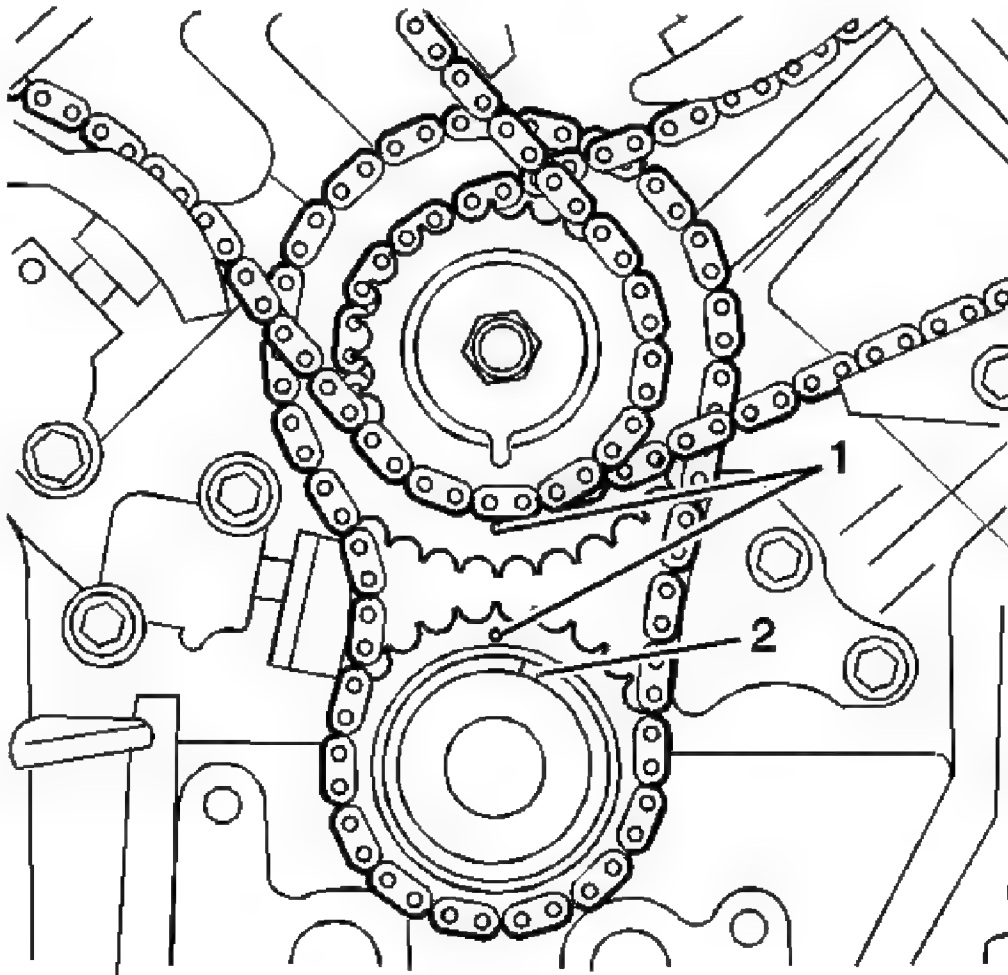


Fig. 66: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS CORP.

20. Ensure the correct alignment of all primary timing components (1, 2).

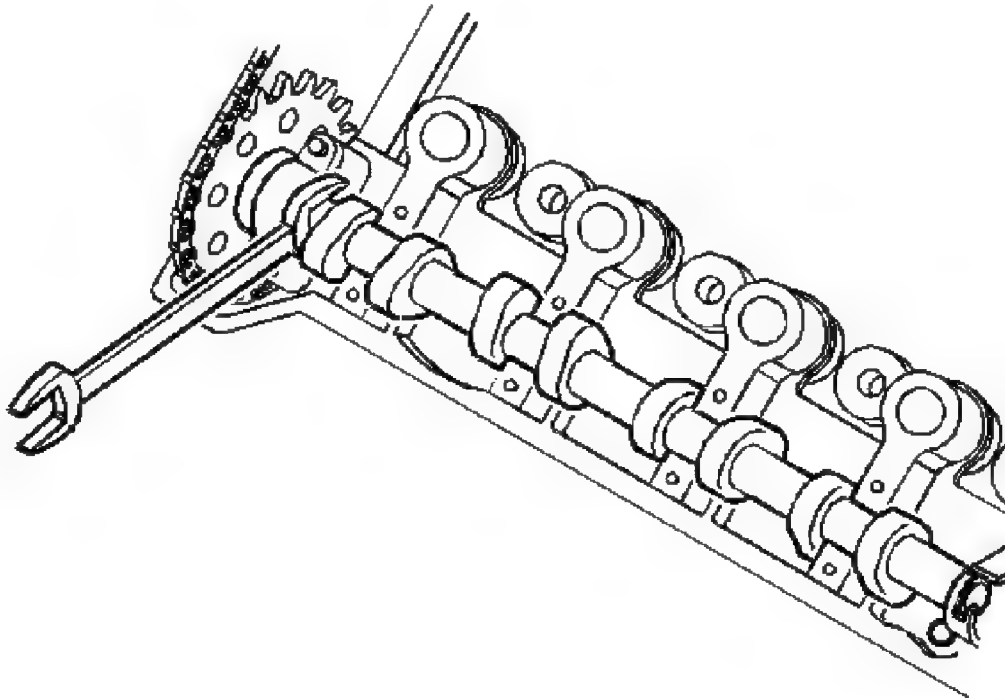


Fig. 67: Aligning Sprocket Notch-To-Camshaft Pin
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

21. Tighten ALL camshaft sprocket bolts. Use the hex cast into each camshaft to prevent engine rotation and provide leverage.

Tighten: Tighten ALL camshaft sprocket bolts to 120 N.m (90 lb ft).

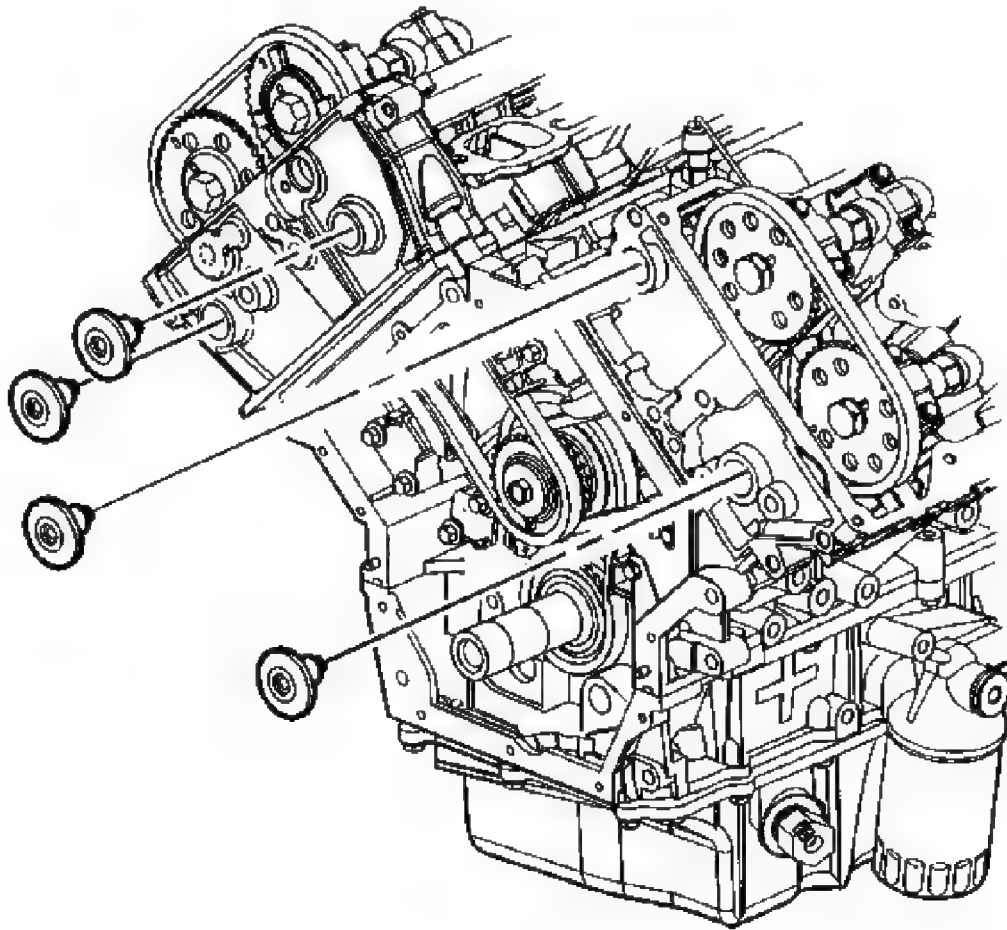


Fig. 68: Identifying Cylinder Head Core Hole Plugs
Courtesy of GENERAL MOTORS CORP.

22. Install the cylinder head core hole plugs located in the cylinder heads. Ensure the O-ring seal is on each cylinder head core hole plug.

Tighten: Tighten the cylinder head core hole plugs to 4.5 N.m (39 lb in).

OIL PUMP INSTALLATION

TOOLS REQUIRED

J 45059 Angle Meter

INSTALLATION PROCEDURE

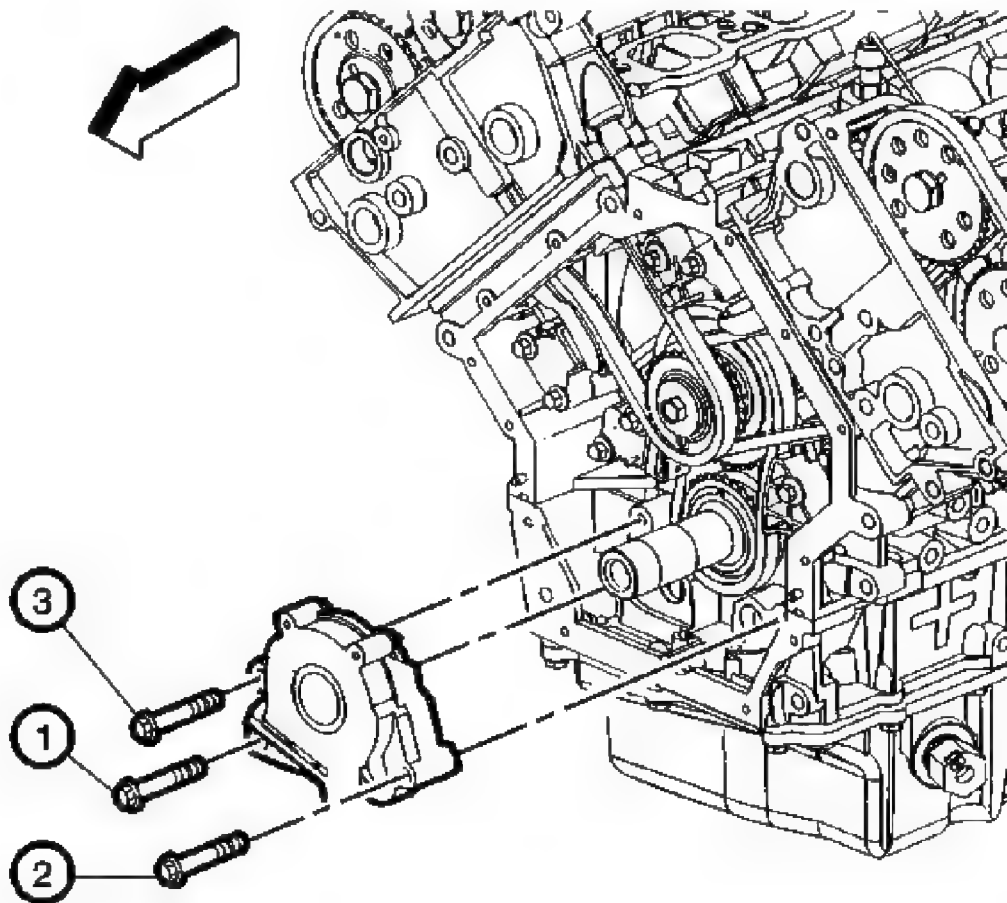


Fig. 69: Identifying Oil Pump Assembly Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump drive spacer into the oil pump so that the drive flat engages the pump rotor.
2. Position the oil pump on the crankshaft.
3. Install the retaining bolts.

NOTE: Refer to Fastener Notice .

4. Apply upward pressure on the pump while tightening the three retaining bolts. Tighten the bolts in the sequence (1, 2, 3) shown.
 1. First Pass

Tighten: Tighten the oil pump mounting bolts in sequence to 10 N.m (89 lb in).

2. Final Pass

Tighten: Tighten the oil pump mounting bolts in sequence an additional 35 degrees using the **J 45059** .

CRANKSHAFT FRONT OIL SEAL INSTALLATION

The crankshaft front oil seal is not serviced as an individual component. When replacing the crankshaft front oil seal install a NEW engine front cover. In order to precisely align the crankshaft front oil seal to the crankshaft balancer and crankshaft balancer dust shield the engine front cover and the crankshaft front oil seal are sold as an assembly.

ENGINE FRONT COVER INSTALLATION

TOOLS REQUIRED

J 28410 Gasket Remover (Aluminum Components). See **Special Tools** .

INSTALLATION PROCEDURE

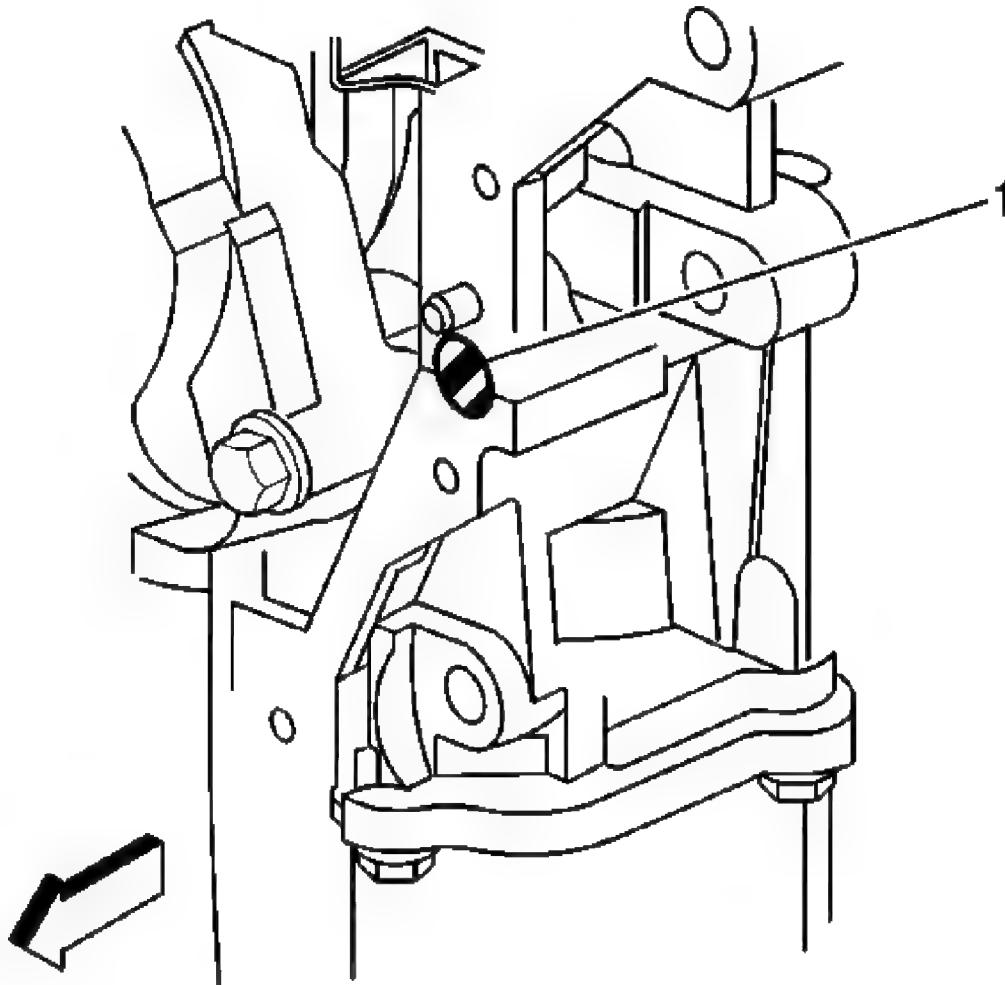


Fig. 70: View Of Split Line Of Upper & Lower Crankcase
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 28410** remove any cured excess RTV sealant at the split line of the upper and lower crankcase (1). See **Special Tools** .
2. Place a small amount of fresh RTV sealant GM P/N 12378521, (Canadian P/N 88901148) or equivalent at the split line of the upper and lower crankcases (1).

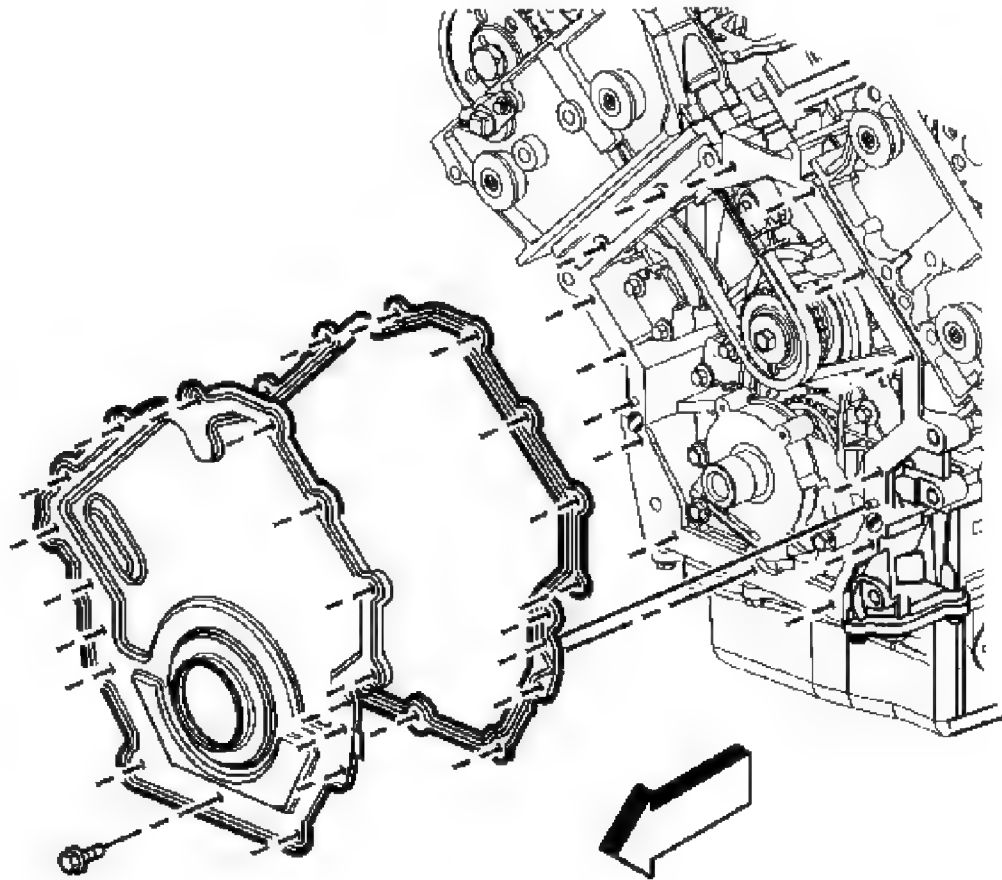


Fig. 71: View of Engine Front Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Place the engine front cover gasket over the crankcase dowel pins.
4. Place the engine front cover in position on the crankcase.
5. Apply the thread locking compound GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the threads of the engine front cover bolts.
6. Install the engine front cover bolts.

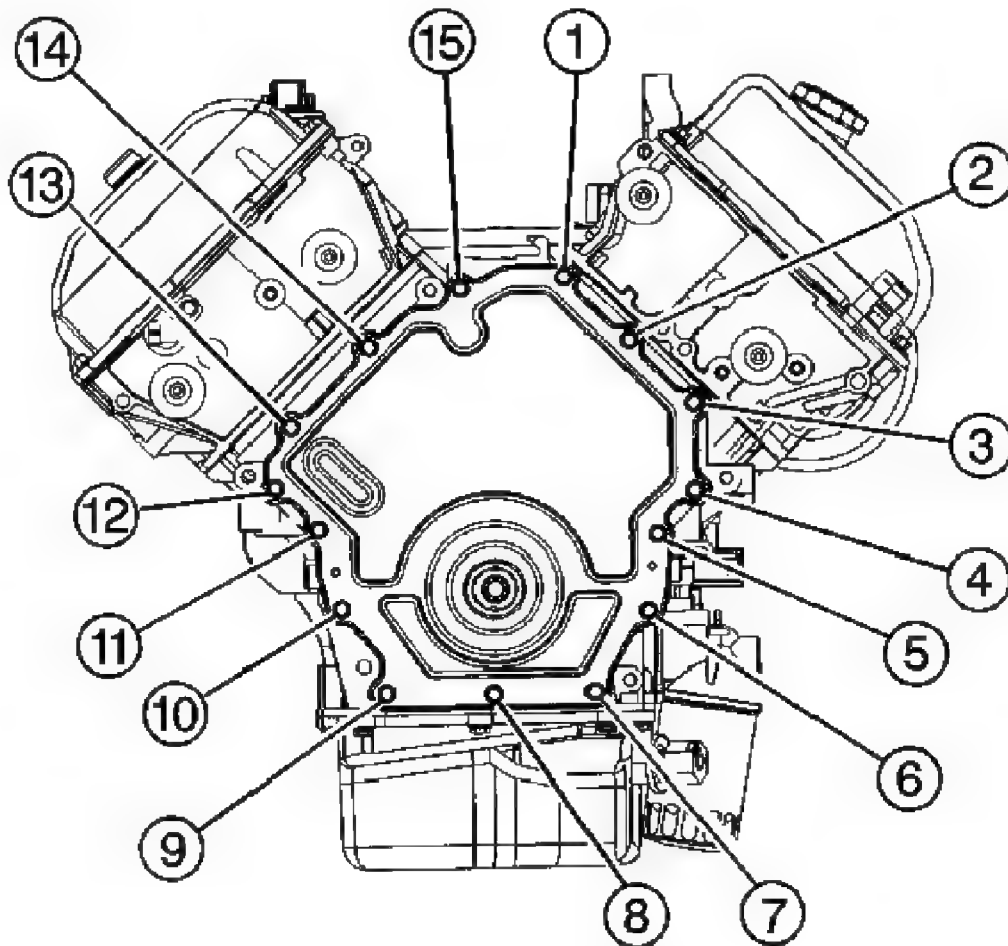


Fig. 72: Identifying Engine Front Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

7. Tighten the engine front cover bolts in the sequence shown.

Tighten: Tighten the engine front cover bolts in the proper sequence to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - LEFT SIDE

TOOLS REQUIRED

- **J 38823** Water Pump Pulley Installer. See Special Tools .

- **J 44212** Camshaft Holding Tool. See Special Tools .

INSTALLATION PROCEDURE

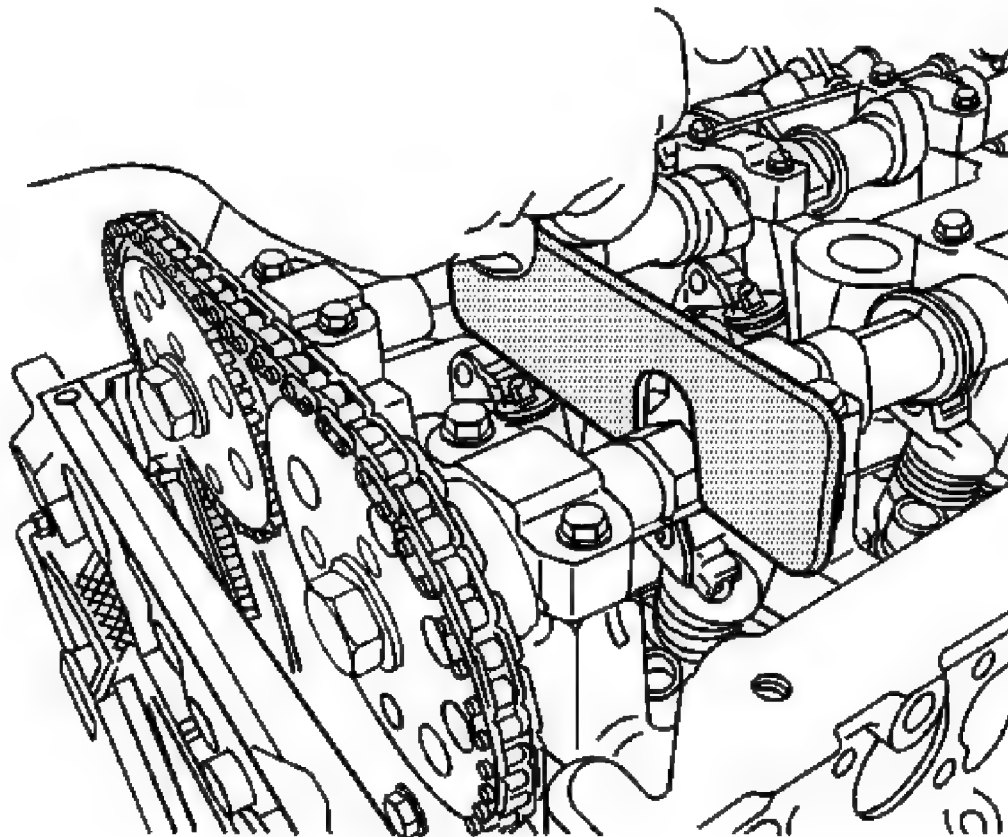


Fig. 73: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

1. Remove the **J 44212** from the left cylinder head camshafts. See Special Tools .

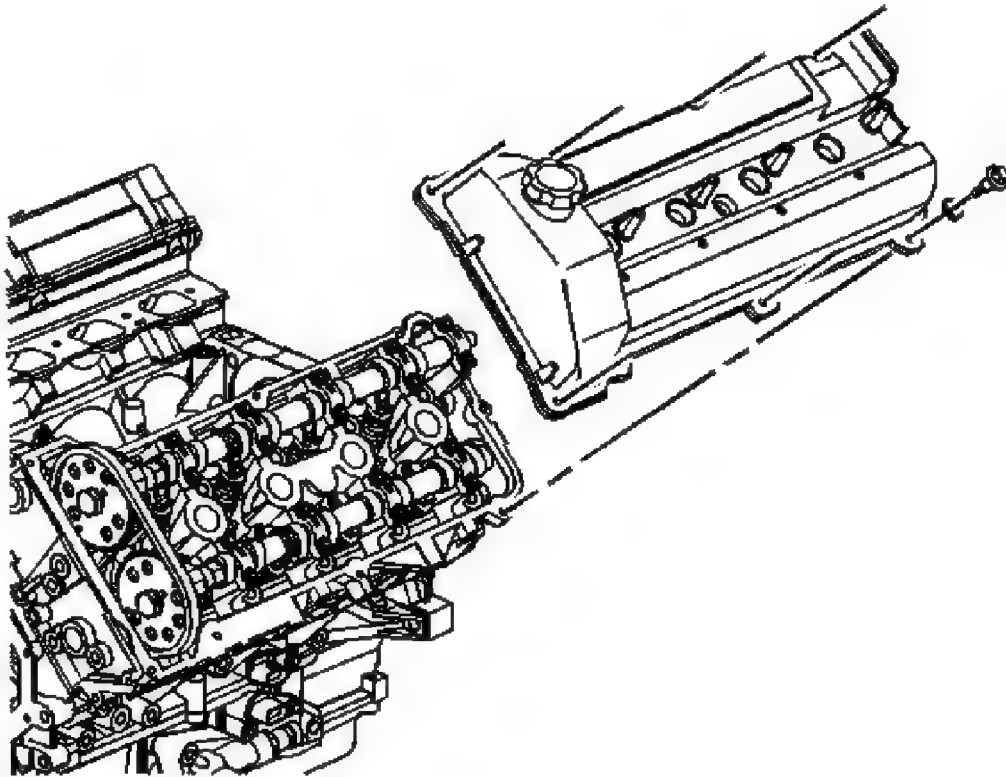


Fig. 74: View of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

2. Ensure new camshaft cover seals are installed.
3. Place the camshaft cover in position on the cylinder head.

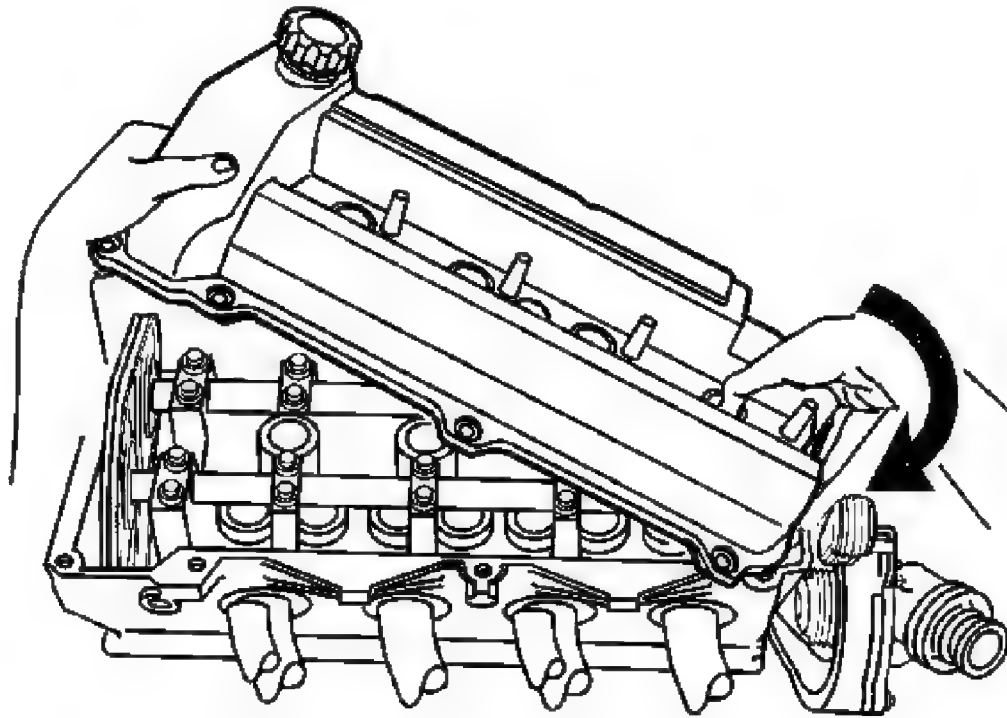


Fig. 75: Positioning Intake Camshaft End Through Hole In End Of Camshaft Cover

Courtesy of GENERAL MOTORS CORP.

4. Insert the intake camshaft end through the hole in the end of the camshaft cover.

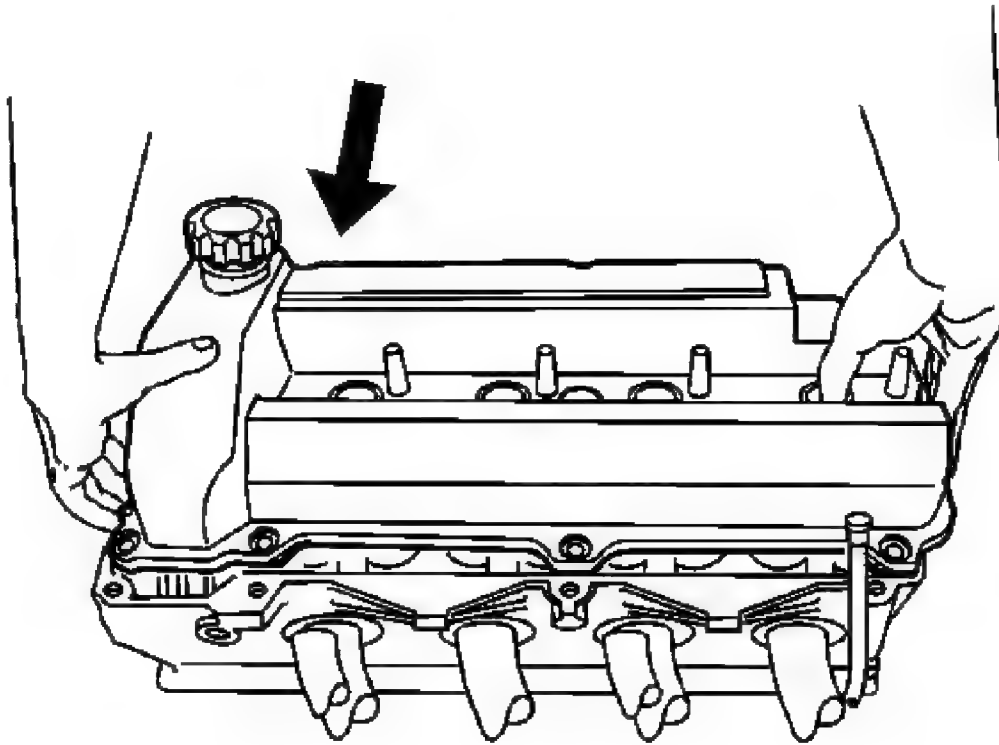


Fig. 76: Replacing Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

5. Using your fingers, guide the camshaft cover up over the edge of the cylinder head. Be careful not to damage the exposed section of the camshaft cover seal on the edge of the cylinder head.

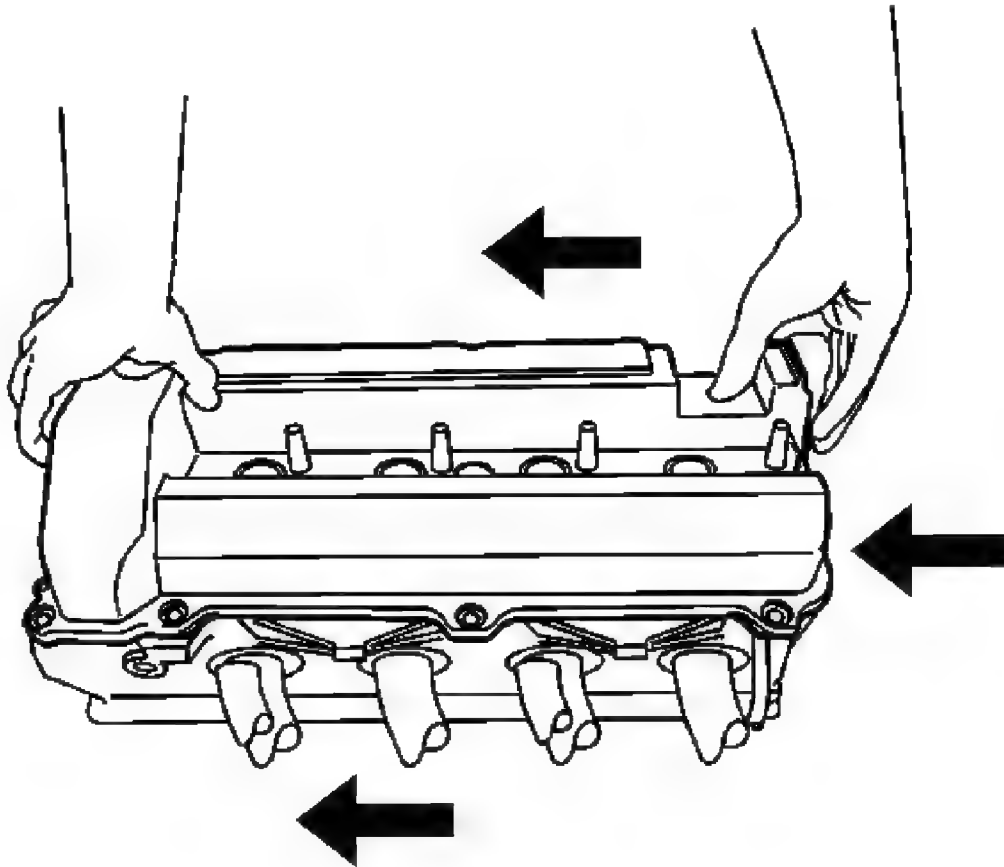


Fig. 77: Positioning Left Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

6. Work the camshaft cover into position by pivoting the cover down and to the left allowing the cover to clear the camshaft drive chain and then aligning the bolt holes.

NOTE: Refer to Fastener Notice .

7. Install the camshaft cover bolts.

Tighten: Tighten the camshaft cover bolts to 10 N.m (89 lb in).

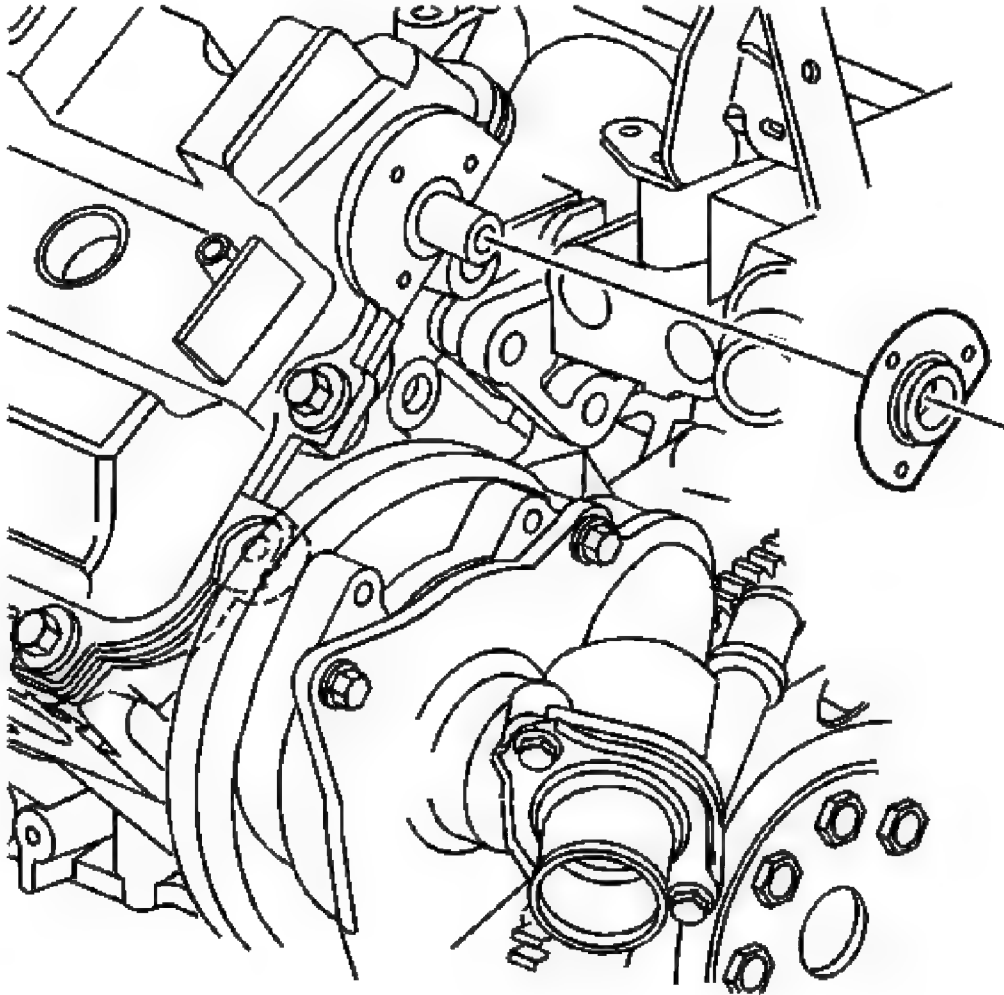


Fig. 78: View Of Camshaft Seal
Courtesy of GENERAL MOTORS CORP.

8. Install a new camshaft seal as follows:
 1. Lubricate the lips of the camshaft seal with engine oil.
 2. Push the camshaft seal into position around the intake camshaft using the protective sleeve supplied with the seal.

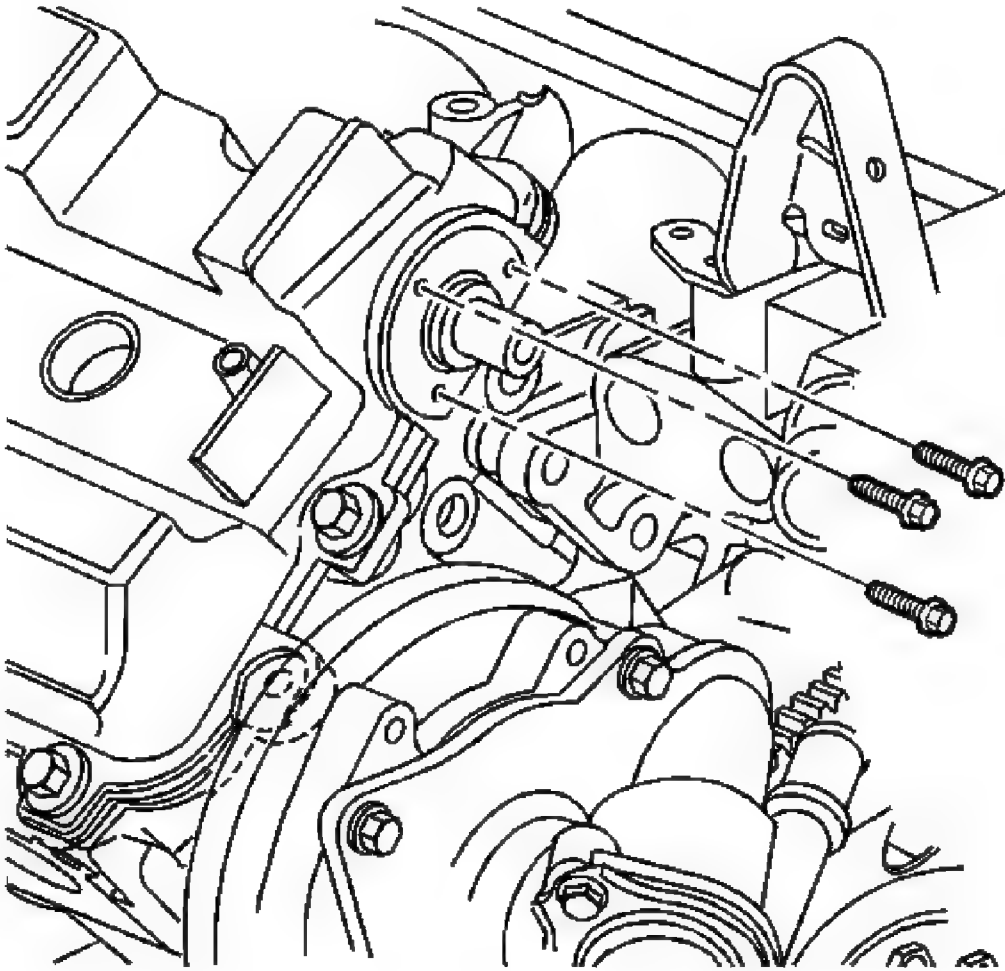


Fig. 79: View Of Camshaft Cover Seal Screws
Courtesy of GENERAL MOTORS CORP.

9. Coat the seal screws with sealant, GM P/N 1052080, (Canadian P/N 10953480) or equivalent.
10. Install the screws.

Tighten: Tighten the camshaft cover seal screws to 3 N.m (27 lb in).

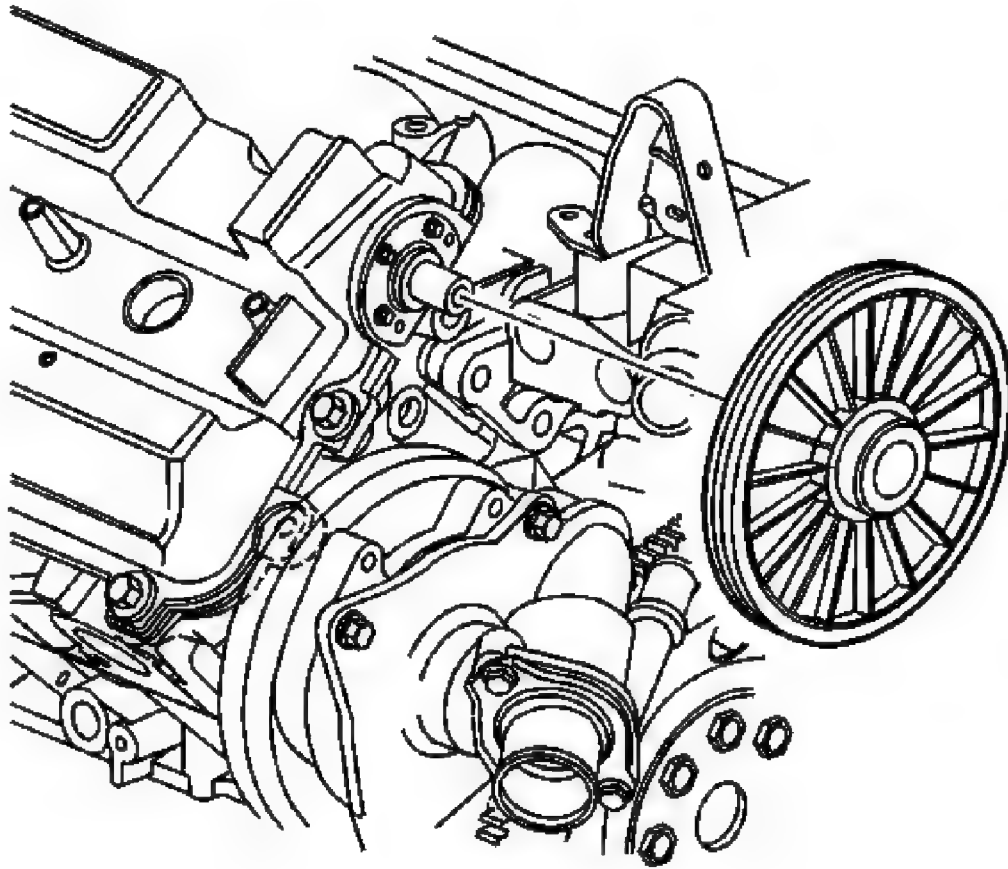


Fig. 80: View of Water Pump Drive Pulley
Courtesy of GENERAL MOTORS CORP.

11. Place the water pump drive pulley in position on the intake camshaft.

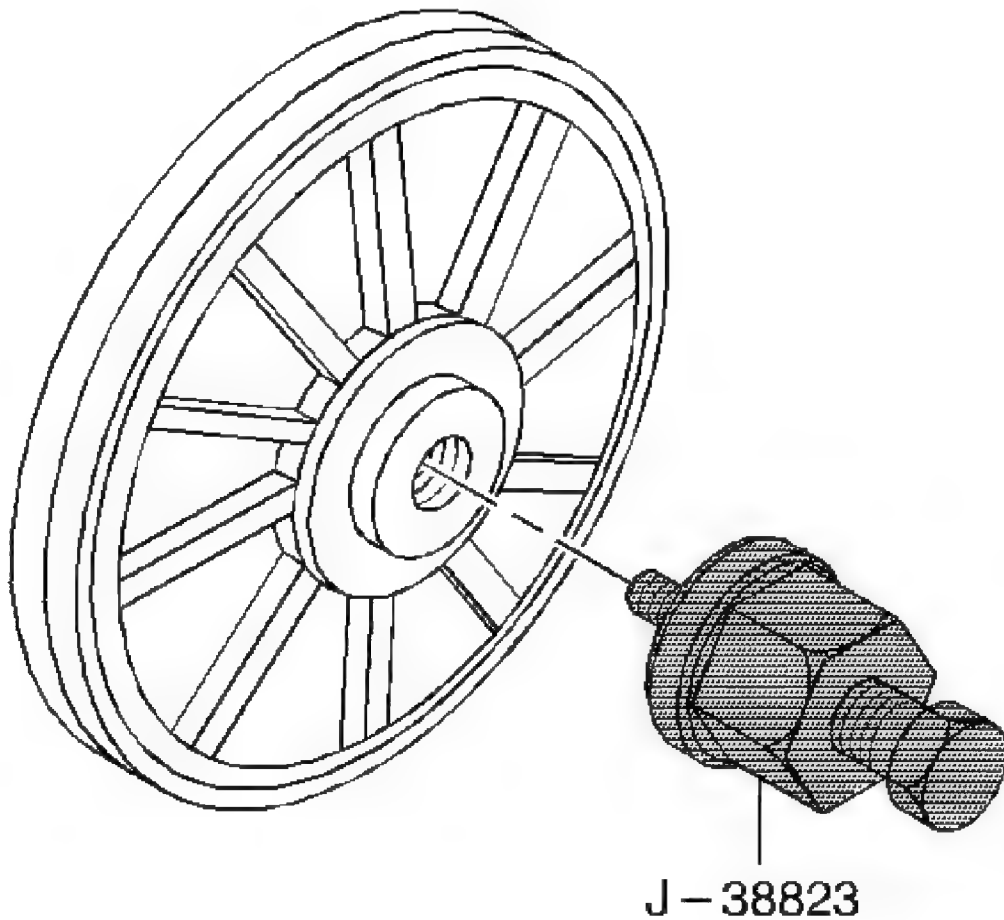


Fig. 81: View of J 38823 Installing Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

12. Install the water pump pulley on the intake camshaft using the **J 38823** . See **Special Tools** . During installation, the tool will bottom out on the camshaft at the proper depth.

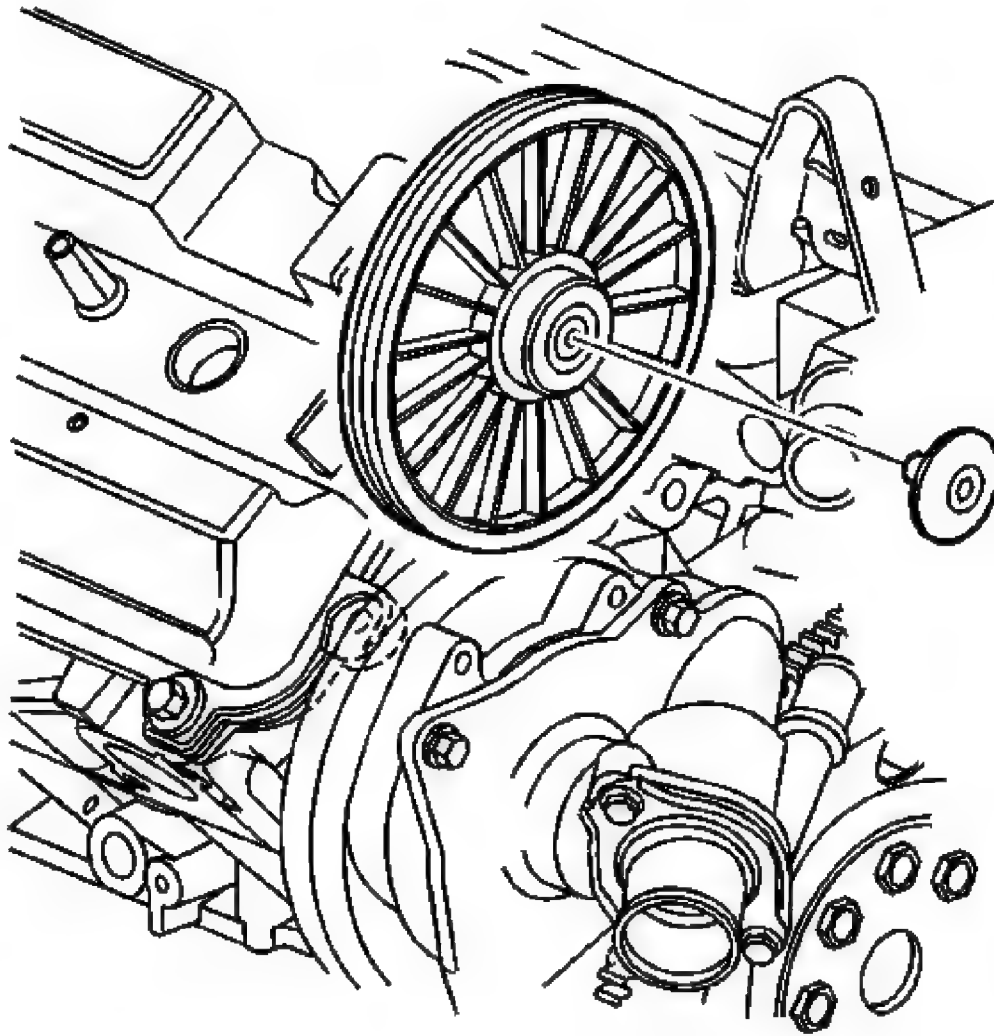


Fig. 82: Identifying Intake Camshaft End Cap
Courtesy of GENERAL MOTORS CORP.

13. Install the camshaft end cap in the camshaft.

Tighten: Tighten the camshaft end cap to 2 N.m (18 lb in).

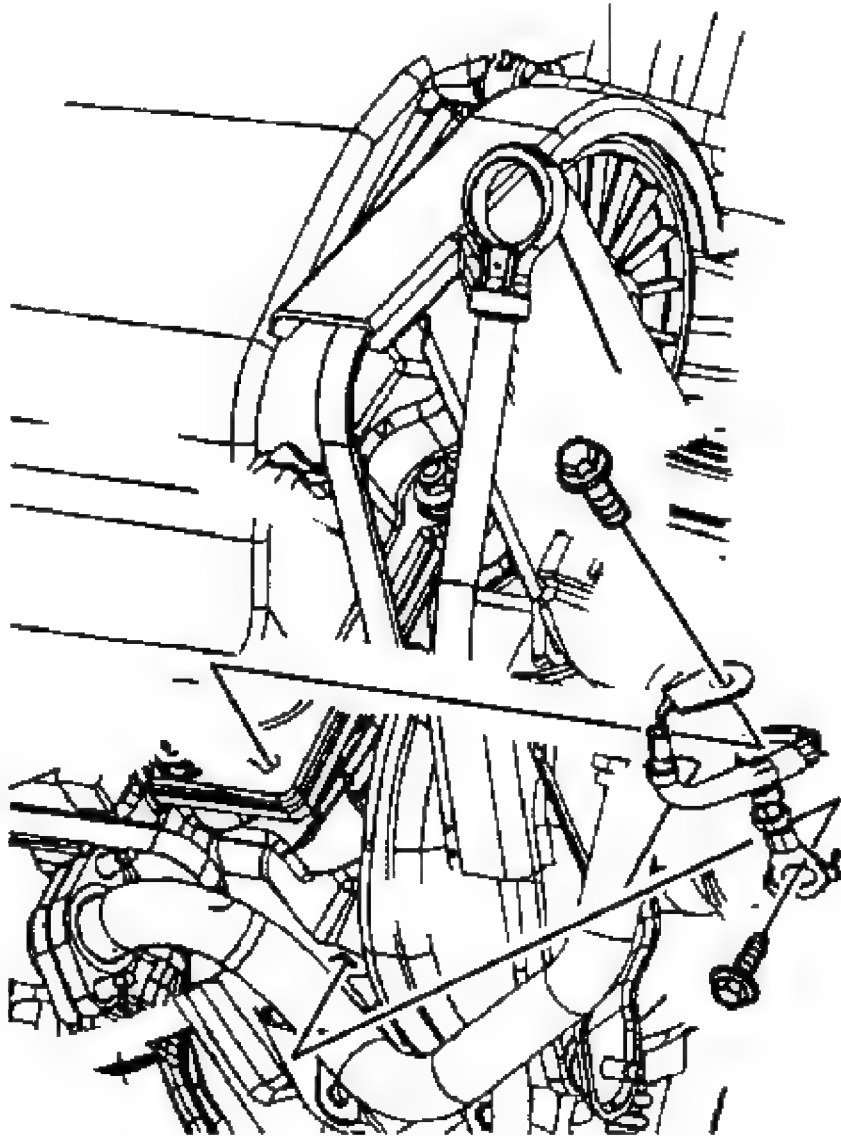


Fig. 83: Identifying Left Camshaft Cover Ignition Coil Ground Strap Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the left ignition coil ground strap to the left cylinder head and left camshaft cover.
15. Install the left cylinder head ignition coil ground strap bolt.

Tighten: Tighten the left cylinder head ignition coil ground strap bolt to 25 N.m (18 lb ft).

16. Install the left camshaft cover ignition coil ground strap bolt.

Tighten: Tighten the left camshaft cover ignition coil ground strap bolt to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - RIGHT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See **Special Tools** .

INSTALLATION PROCEDURE

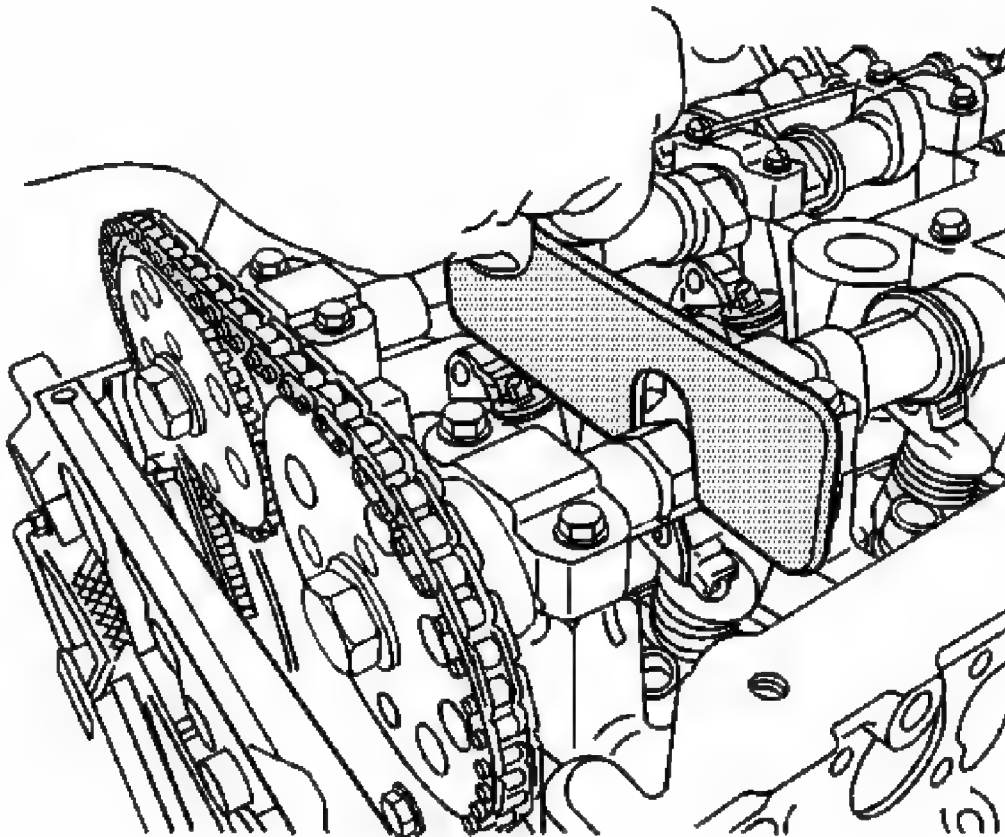


Fig. 84: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

1. Remove the **J 44212** from the right cylinder head camshafts. See **Special Tools** .

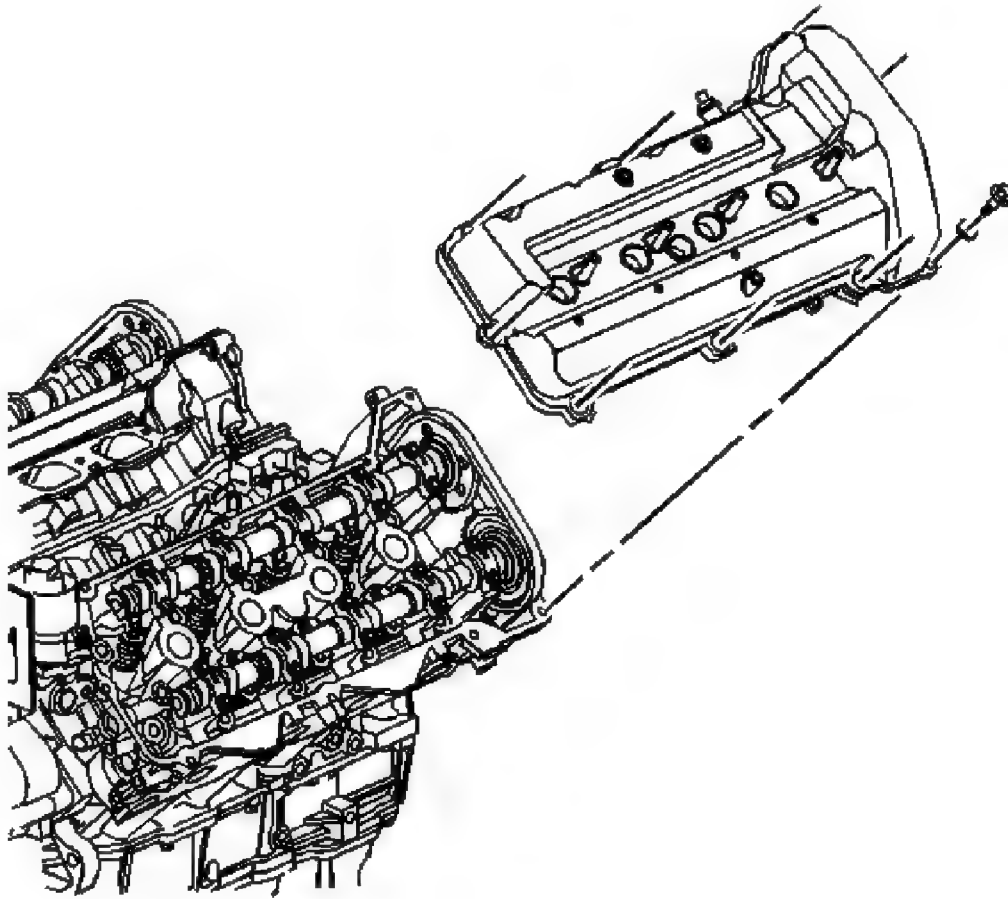


Fig. 85: Removal/Installation Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

2. Ensure new camshaft cover seals are installed.
3. Place the right camshaft cover in position on the cylinder head by aligning the bolt holes.

NOTE: Refer to Fastener Notice .

4. Install the camshaft cover bolts.

Tighten: Tighten the camshaft cover bolts to 10 N.m (89 lb in).

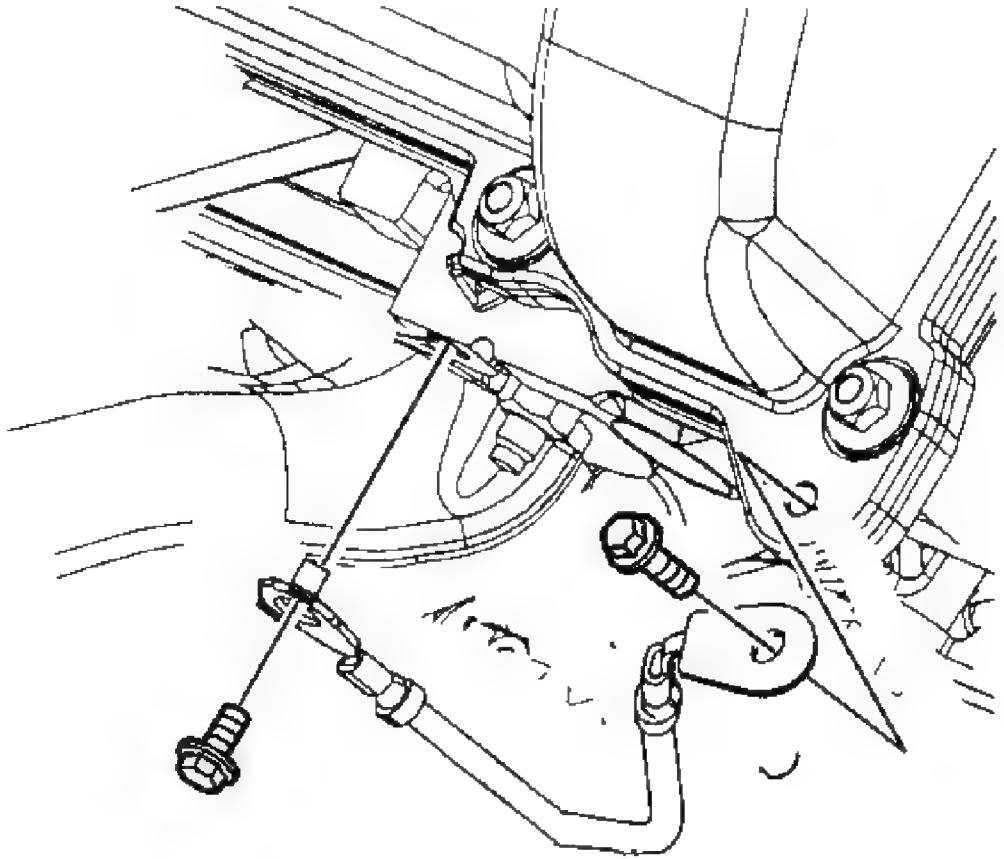


Fig. 86: Identifying Ignition Coil Ground Strap & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the right ignition coil ground strap to the right cylinder head and right camshaft cover.
6. Install the right cylinder head ignition coil ground strap bolt.

Tighten: Tighten the right cylinder head ignition coil ground strap bolt to 25 N.m (18 lb ft).

7. Install the right camshaft cover ignition coil ground strap bolt.

Tighten: Tighten the right camshaft cover ignition coil ground strap bolt to 10 N.m (89 lb in).

IGNITION COIL MODULE INSTALLATION - RIGHT SIDE

INSTALLATION PROCEDURE

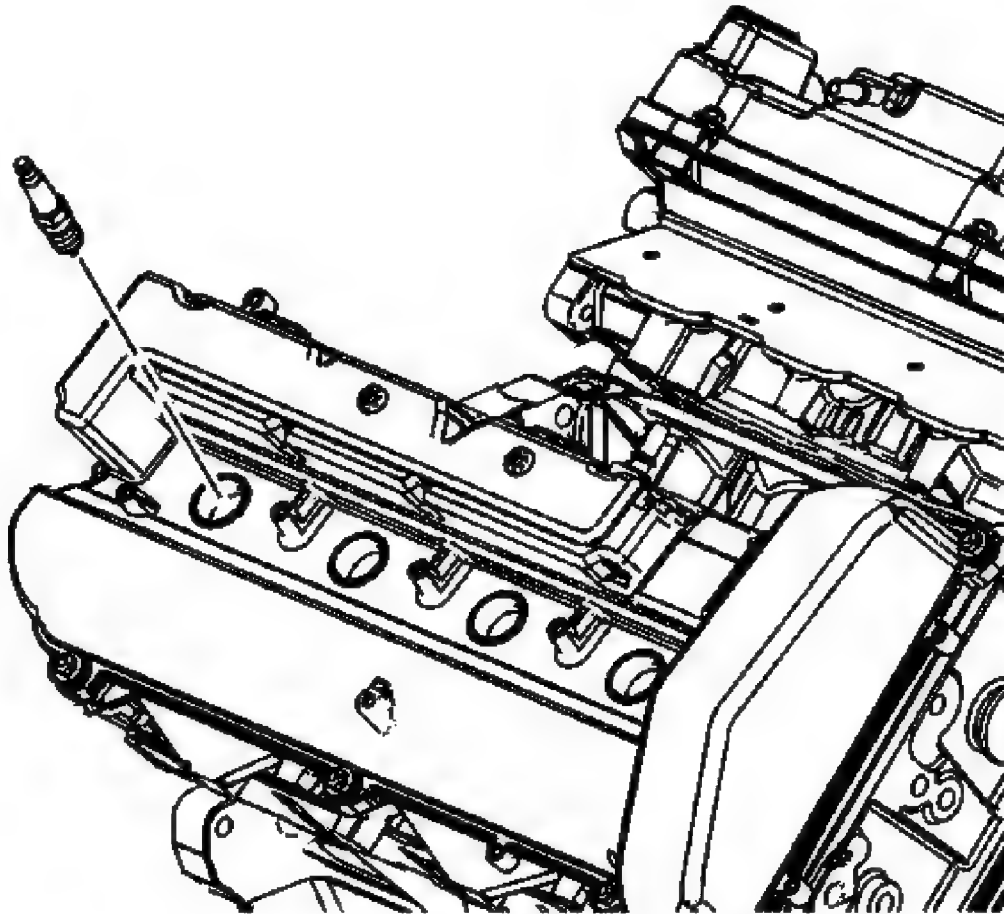


Fig. 87: Identifying Spark Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the right spark plugs.

Tighten: Tighten the spark plugs to 15 N.m (11 lb ft).

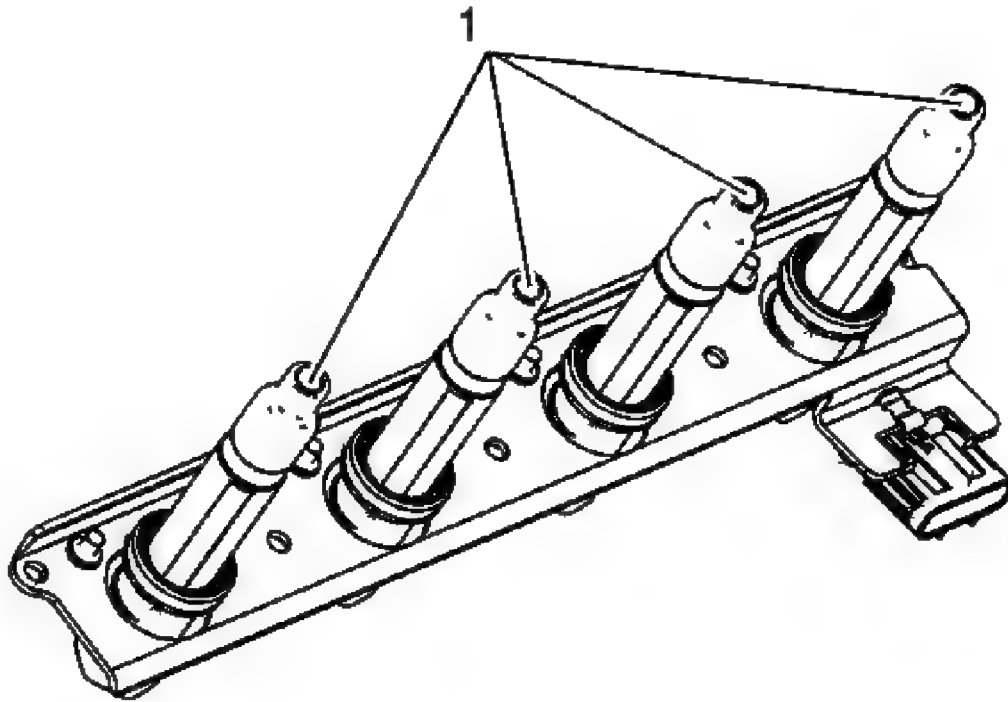


Fig. 88: View Of Spark Plug Boots
Courtesy of GENERAL MOTORS CORP.

2. Apply a small amount of dielectric grease GM P/N 12345579, (Canadian P/N 1974984) to each spark plug boot (1) of the ignition coil assembly.

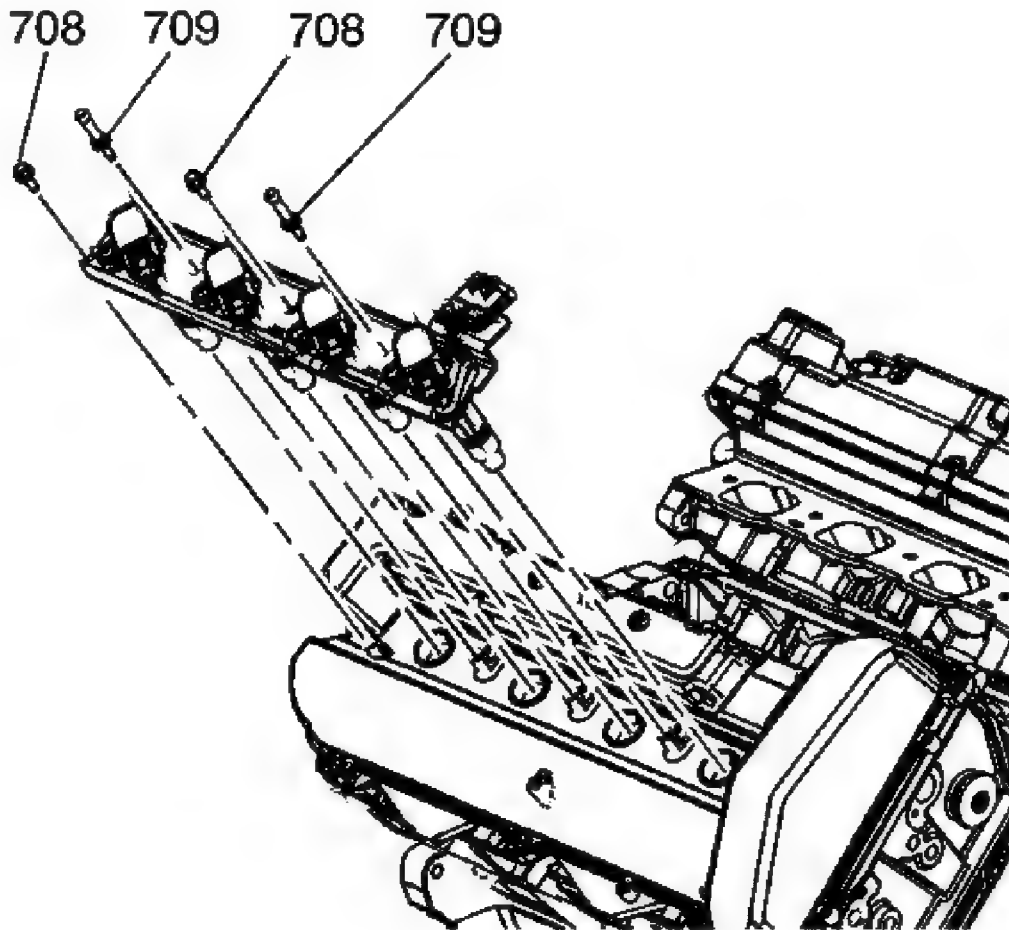


Fig. 89: Identifying Ignition Coil Assembly Bolts & Ball Studs
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil assembly.
4. Install the ignition coil assembly bolts (708) and ball studs (709).

Tighten: Tighten the ignition coil assembly bolts (708) and ball studs (709) to 10 N.m (89 lb in).

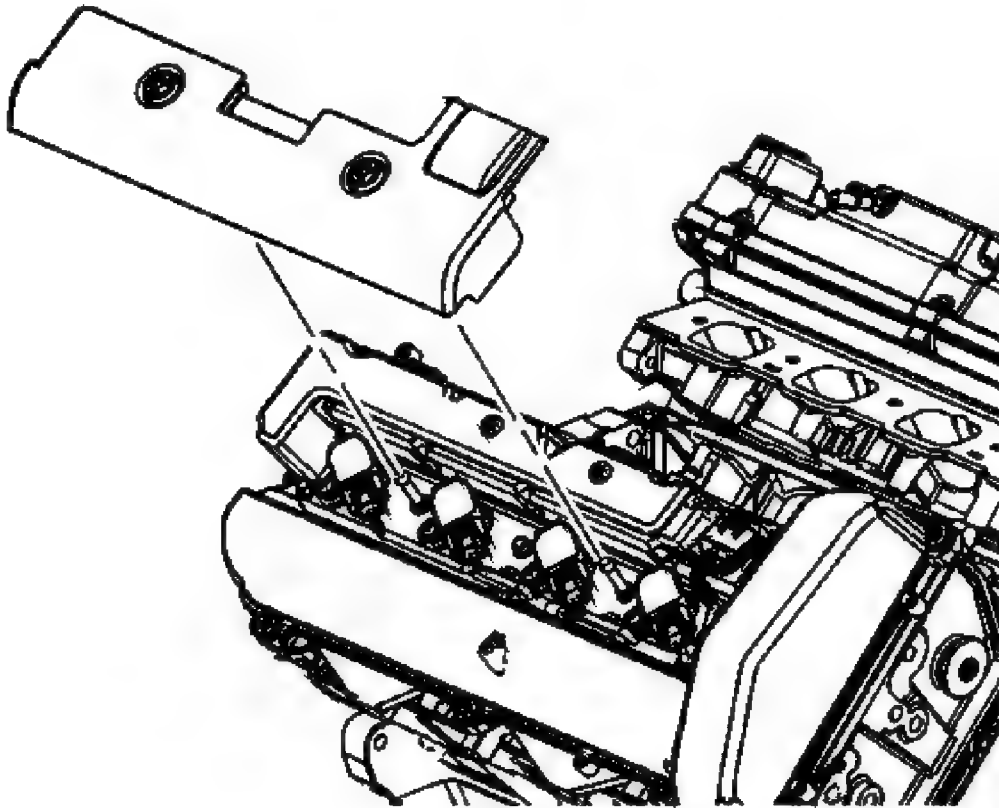


Fig. 90: Identifying Ignition Coil Assembly Sight Shield Cover
Courtesy of GENERAL MOTORS CORP.

5. Install the ignition coil assembly sight shield cover.

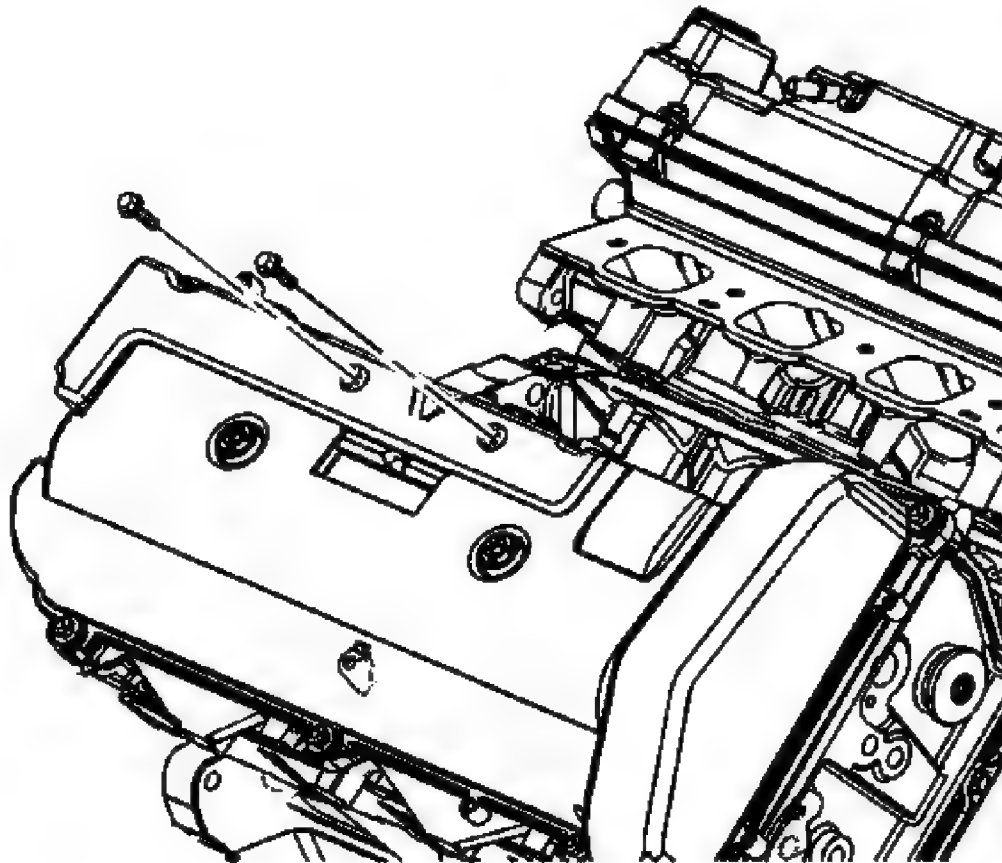


Fig. 91: Identifying Fuel Injector Sight Shield Bracket
Courtesy of GENERAL MOTORS CORP.

6. If equipped, install the fuel injector sight shield bracket.
7. Install the fuel injector sight shield bracket bolts.

Tighten: Tighten the fuel injector sight shield bracket bolts to 10 N.m (89 lb in).

IGNITION COIL MODULE - LEFT SIDE

PROCEDURE

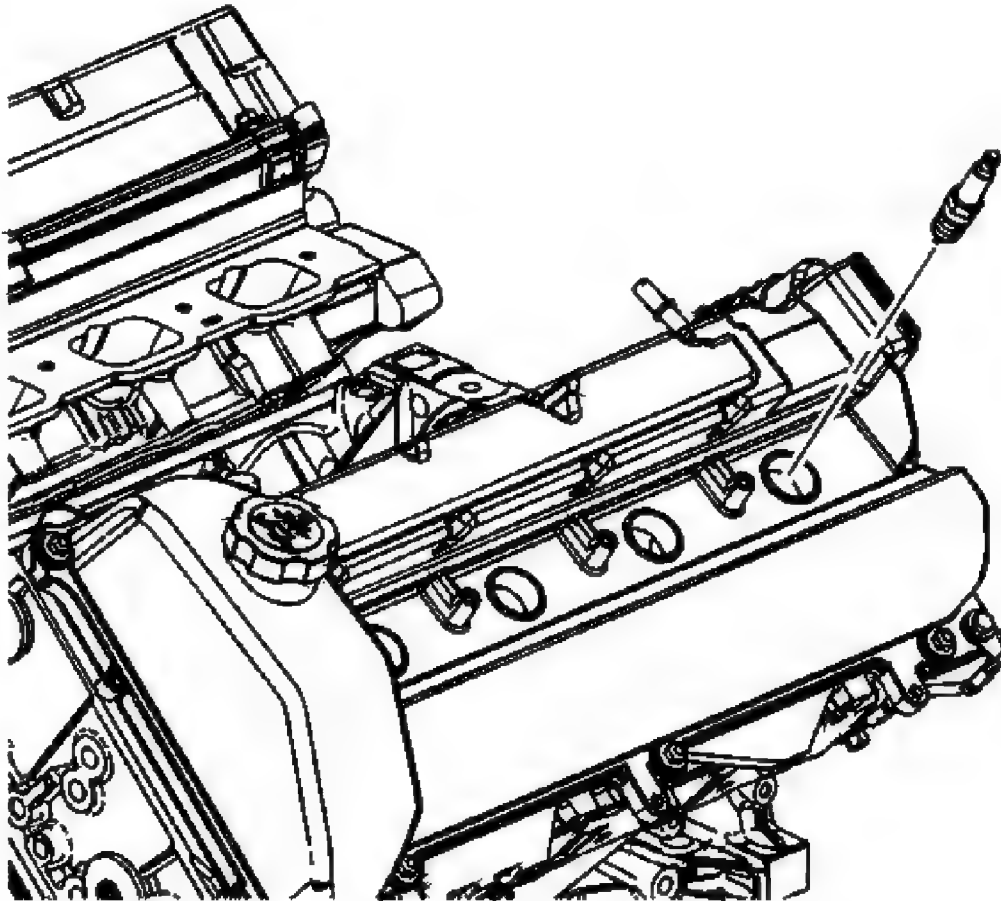


Fig. 92: Identifying Spark Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the left spark plugs.

Tighten: Tighten the spark plugs to 15 N.m (11 lb ft).

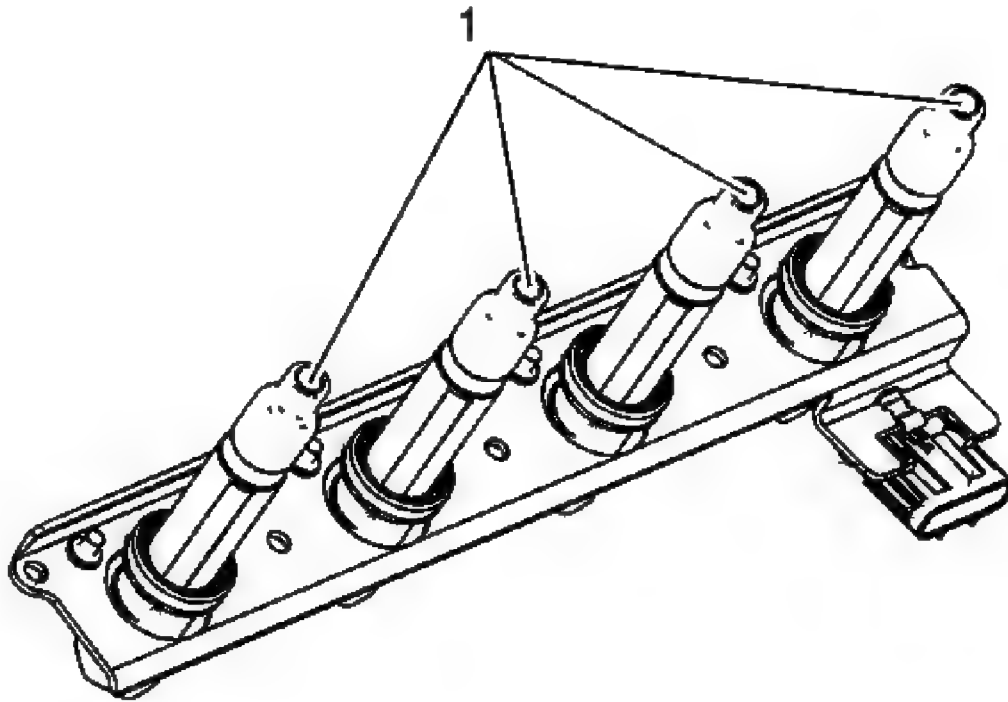


Fig. 93: Identifying Spark Plug Boots
Courtesy of GENERAL MOTORS CORP.

2. Apply a small amount of dielectric grease GM P/N 12345579, (Canadian P/N 1974984) to each spark plug boot (1) of the ignition coil assembly.

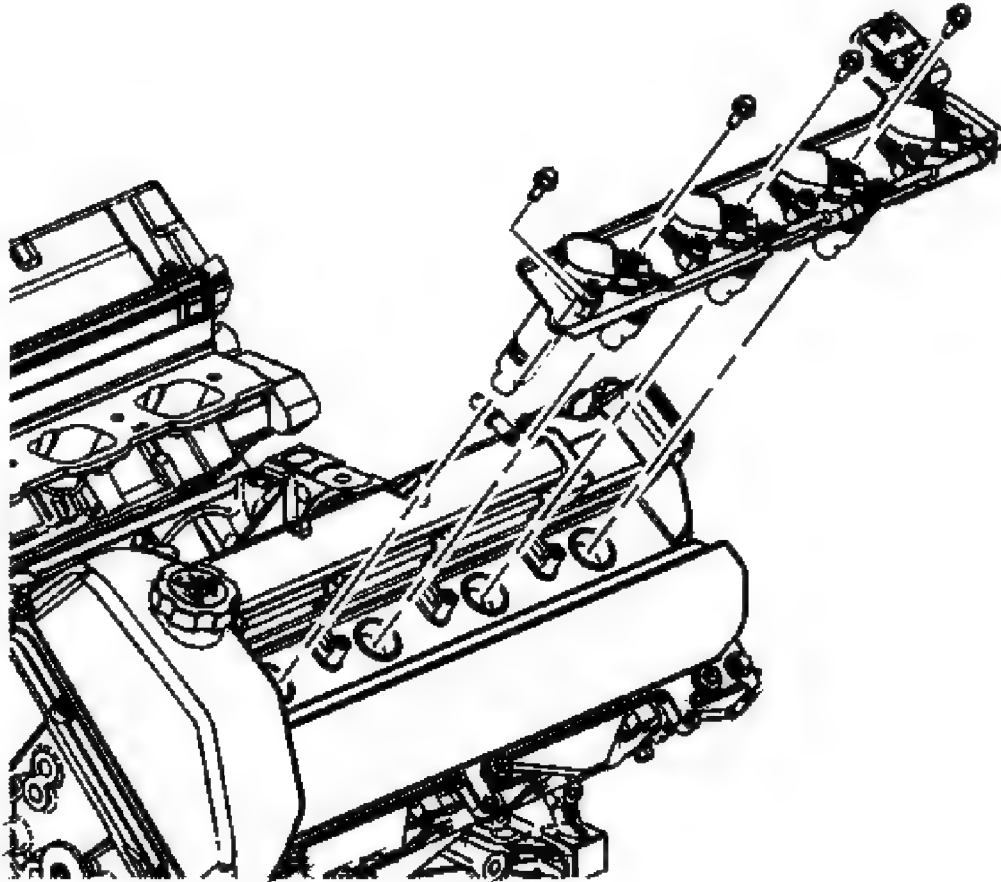


Fig. 94: Identifying Ignition Coil Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil assembly.
4. Install the ignition coil assembly bolts.

Tighten: Tighten the ignition coil assembly bolts to 10 N.m (89 lb in).

STARTER INSTALLATION

INSTALLATION PROCEDURE

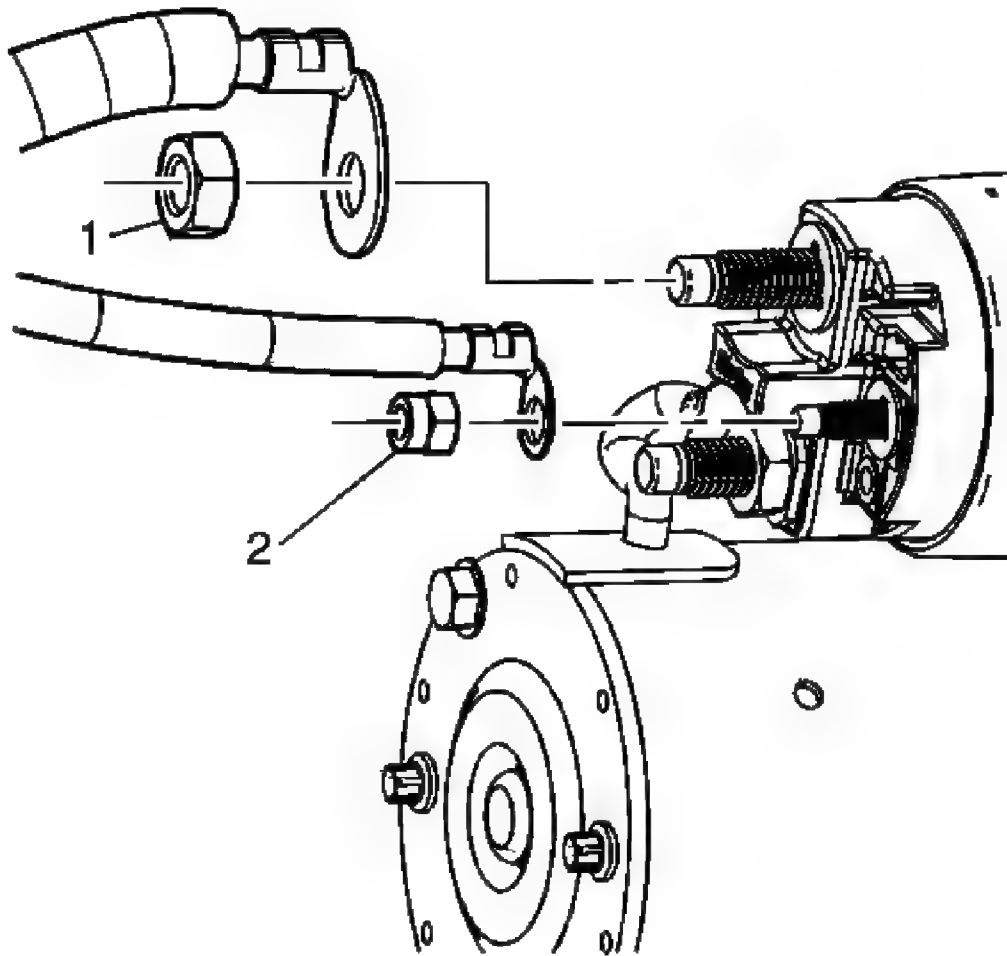


Fig. 95: View Of Starter & Cables
Courtesy of GENERAL MOTORS CORP.

1. If installing a NEW starter transfer the cables from the old starter.
2. Install the positive battery cable to the starter motor stud.

NOTE: Refer to Fastener Notice .

3. Install the starter motor stud nut (1).

Tighten: Tighten the starter motor stud nut (1) to 9.5 N.m (84 lb in).

4. Install the solenoid wiring harness to the starter solenoid stud.
5. Install the starter solenoid stud nut (2).

Tighten: Tighten the starter solenoid stud nut (2) to 3.4 N.m (30 lb in).

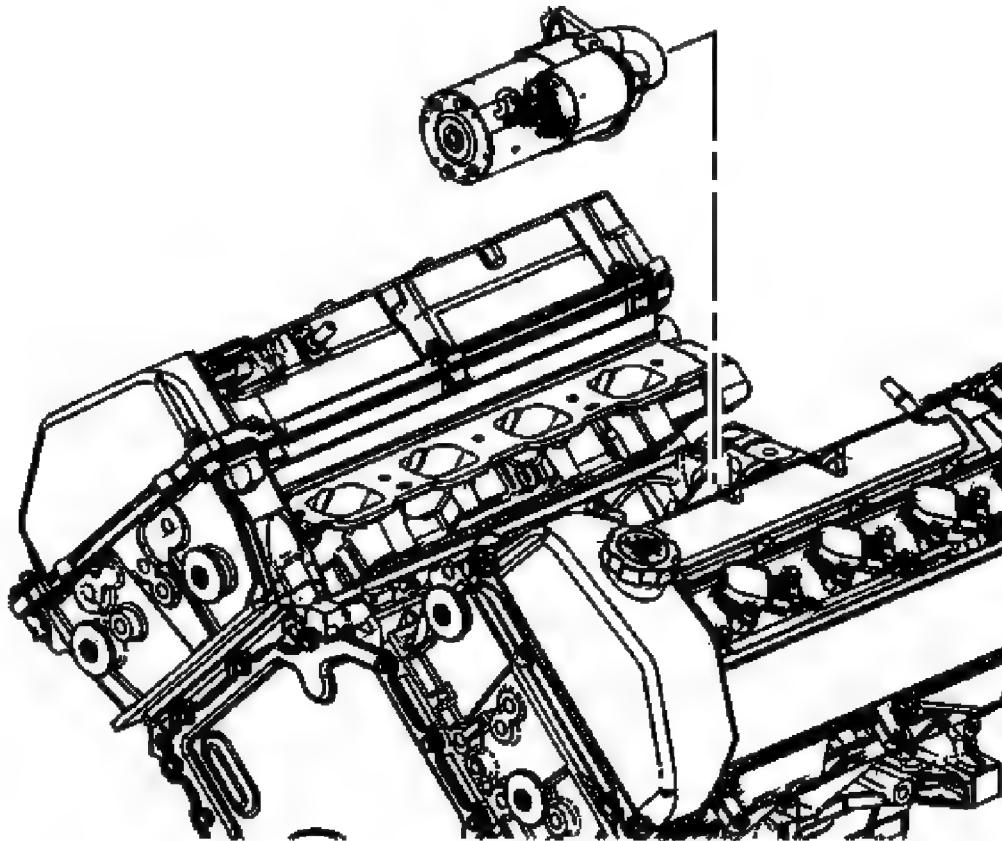


Fig. 96: Locating Starter Motor
Courtesy of GENERAL MOTORS CORP.

6. Place the starter motor in position in the engine valley.

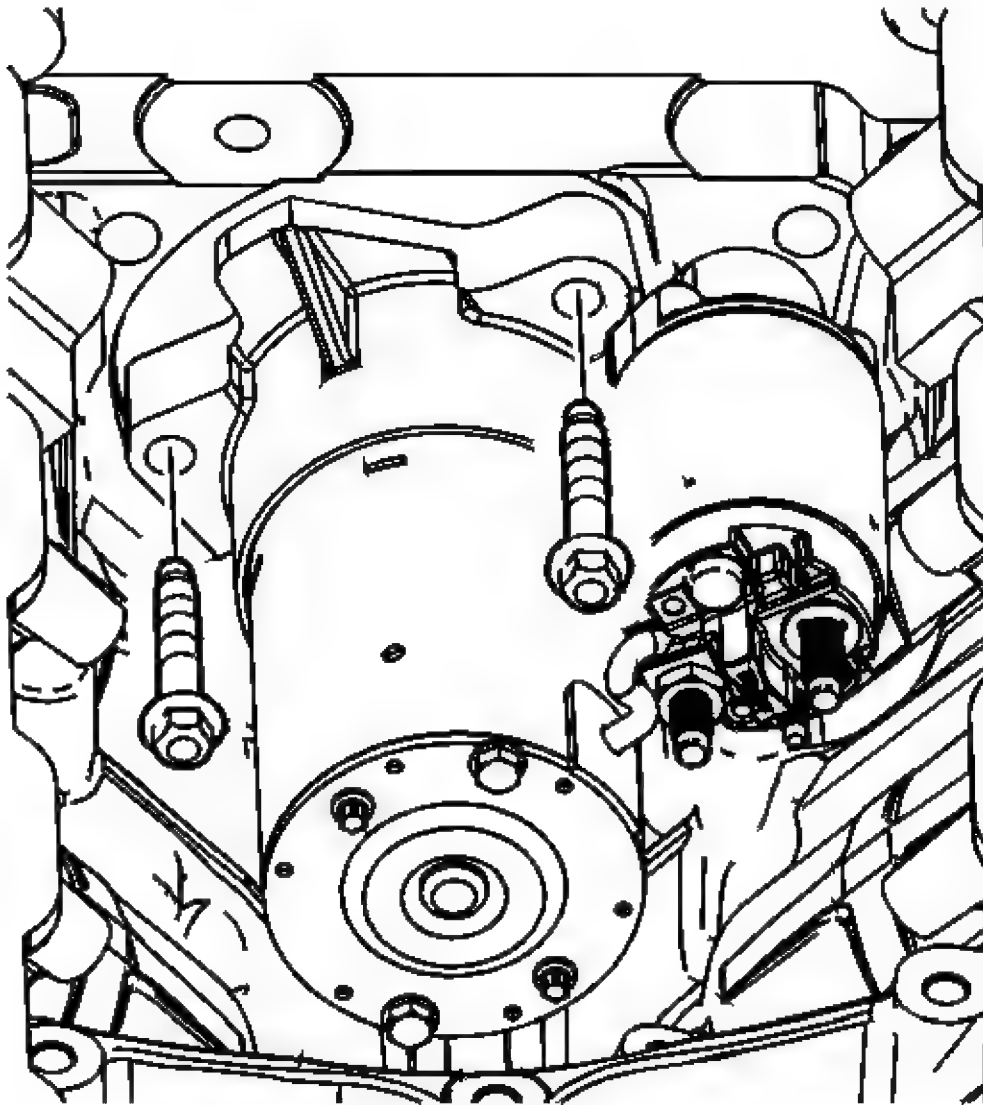


Fig. 97: Identifying Starter Motor Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the two starter motor bolts.

Tighten: Tighten the starter motor bolts to 30 N.m (22 lb ft).

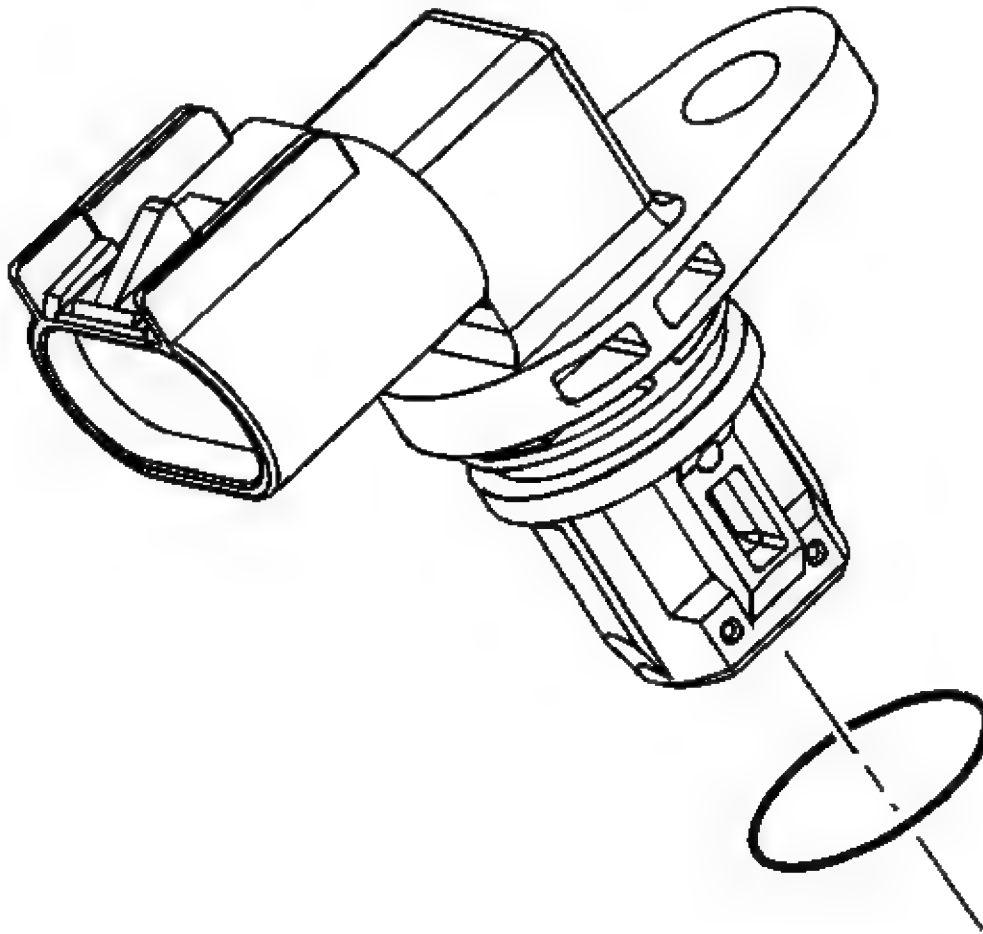


Fig. 98: Identifying CMP Sensor O-Ring
Courtesy of GENERAL MOTORS CORP.

8. Install a NEW O-ring onto the camshaft position (CMP) sensor.
9. Lubricate the O-ring with clean engine oil.

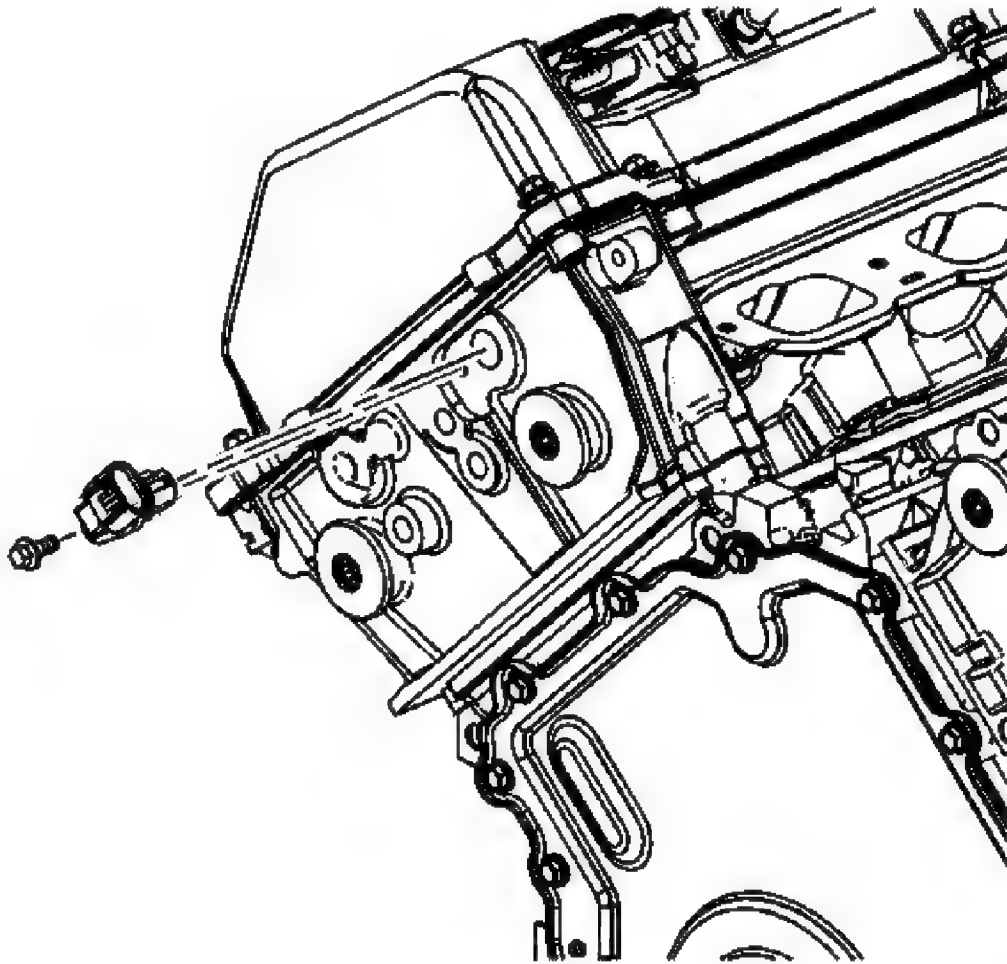


Fig. 99: Identifying CMP Sensor
Courtesy of GENERAL MOTORS CORP.

10. Install the CMP sensor.
11. Install the CMP sensor bolt.

Tighten: Tighten the CMP sensor bolt to 10 N.m (89 lb in).

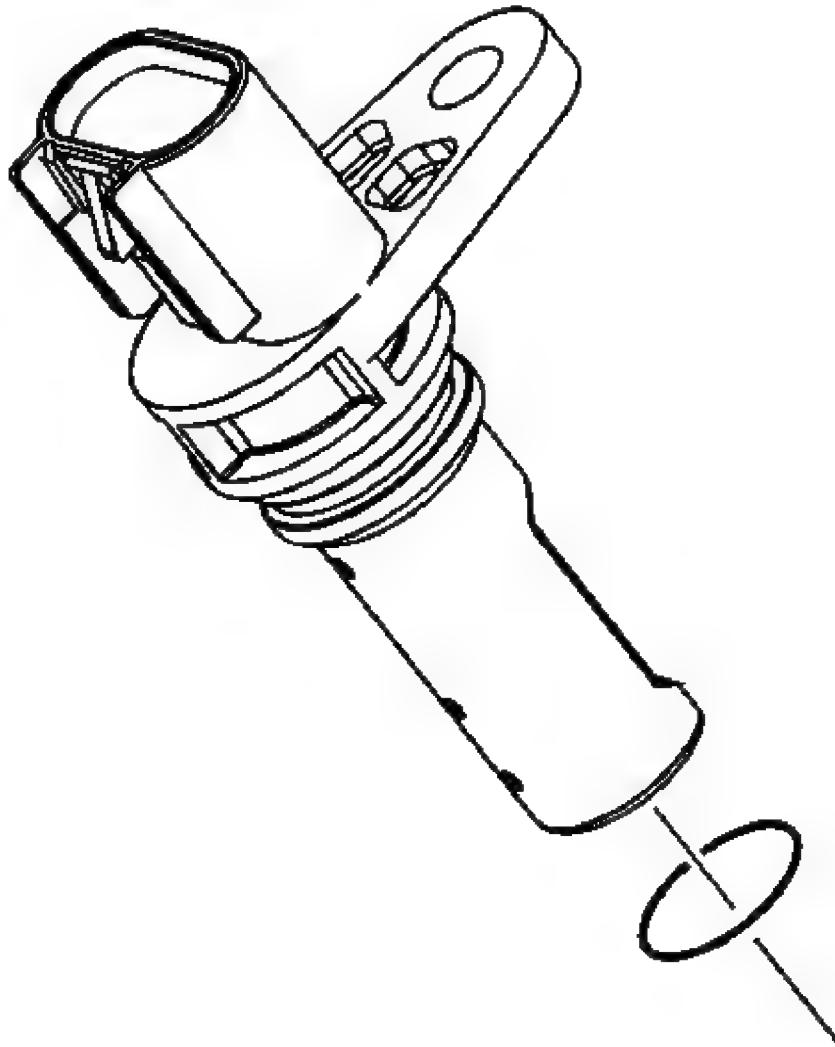


Fig. 100: View Of CKP Sensor O-Ring
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW O-ring onto the crankshaft position (CKP) sensor.
13. Lubricate the O-ring with clean engine oil.

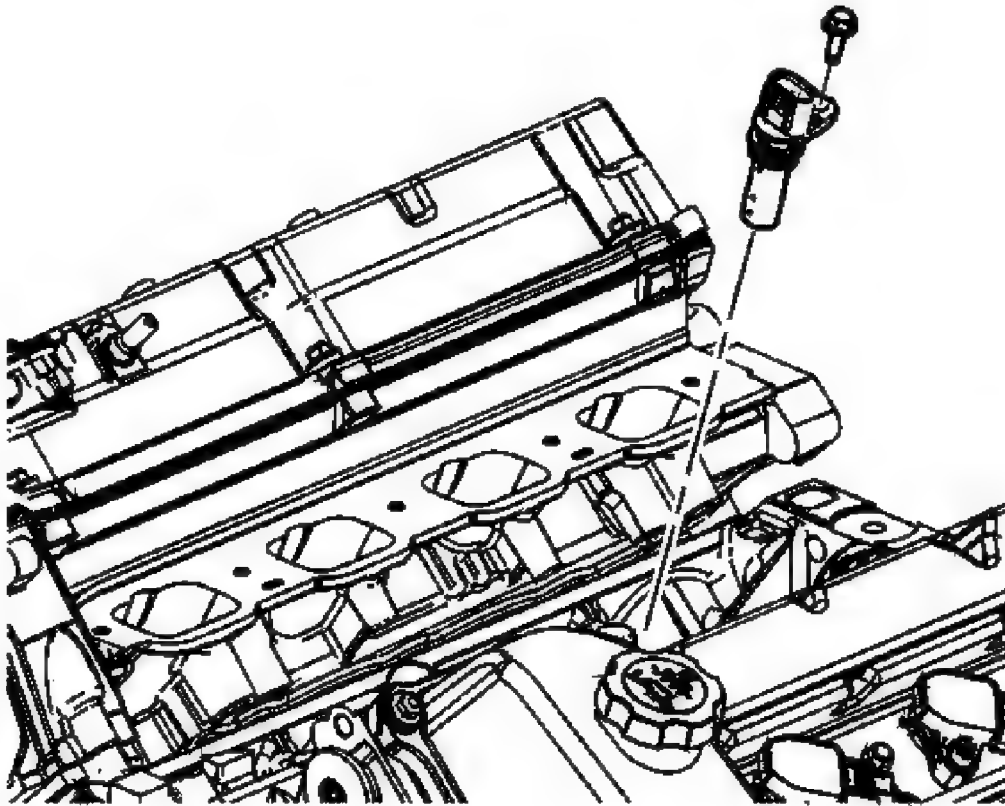


Fig. 101: Locating CKP Sensor
Courtesy of GENERAL MOTORS CORP.

14. Install the CKP sensor.
15. Install the CKP sensor bolt.

Tighten: Tighten the CKP sensor bolt to 10 N.m (89 lb in).

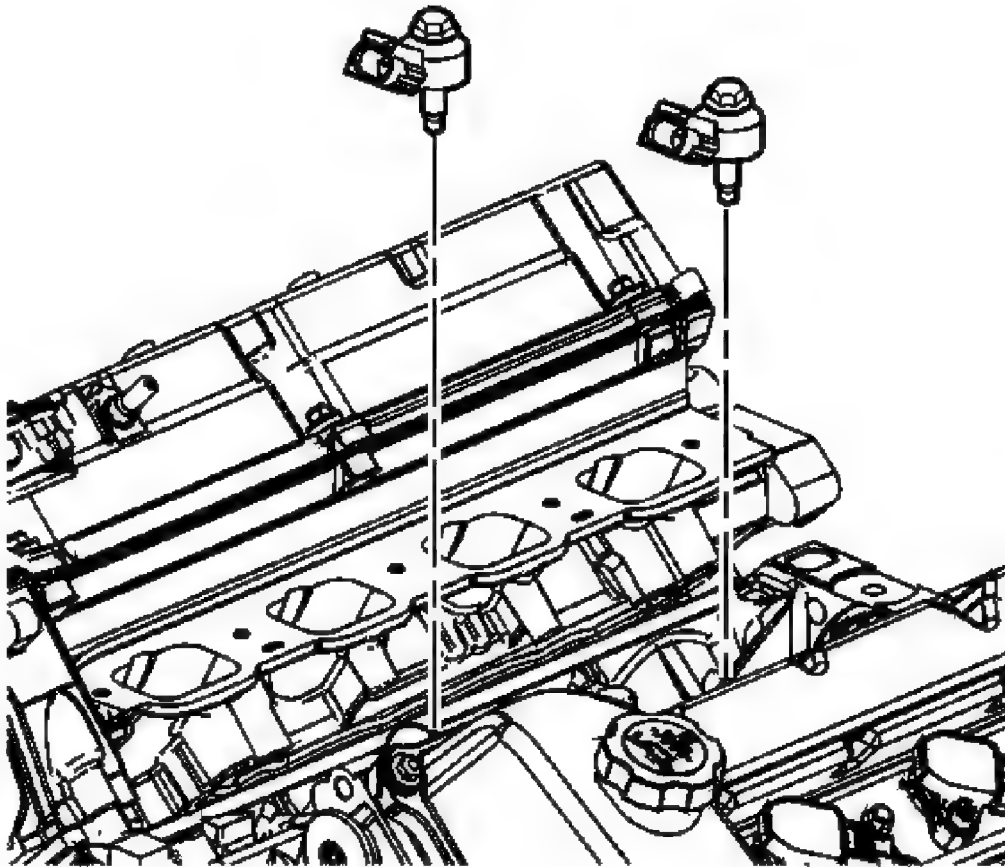


Fig. 102: Locating KS Sensors
Courtesy of GENERAL MOTORS CORP.

16. Install the knock (KS) sensors.

Tighten: Tighten the KS sensors to 20 N.m (15 lb ft).

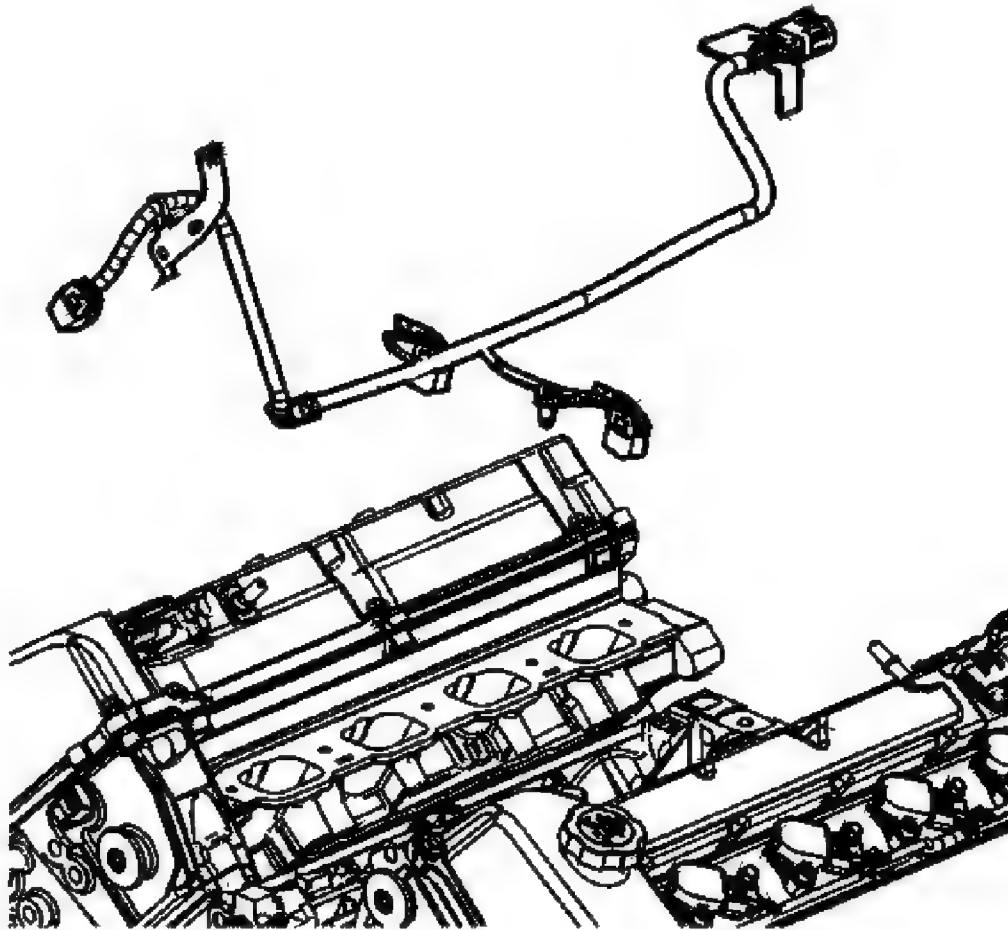


Fig. 103: Identifying Crankshaft Position Sensor Wiring Harness
Courtesy of GENERAL MOTORS CORP.

17. Install the crankshaft position sensor wiring harness into the engine valley.

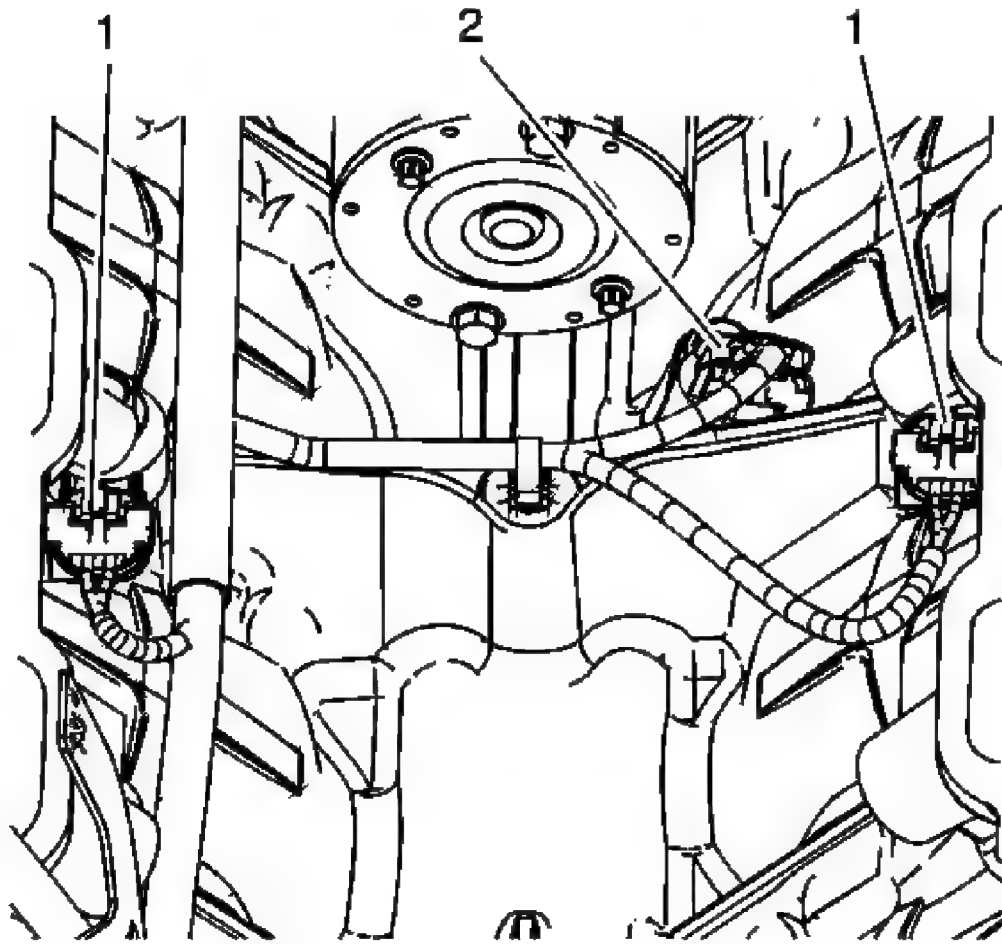


Fig. 104: View Of CKP & KS Sensor Wiring Harness
Courtesy of GENERAL MOTORS CORP.

18. Connect the crankshaft position sensor wiring harness to the KS sensors (1).
19. Connect the crankshaft position sensor wiring harness to the CKP sensor (2).

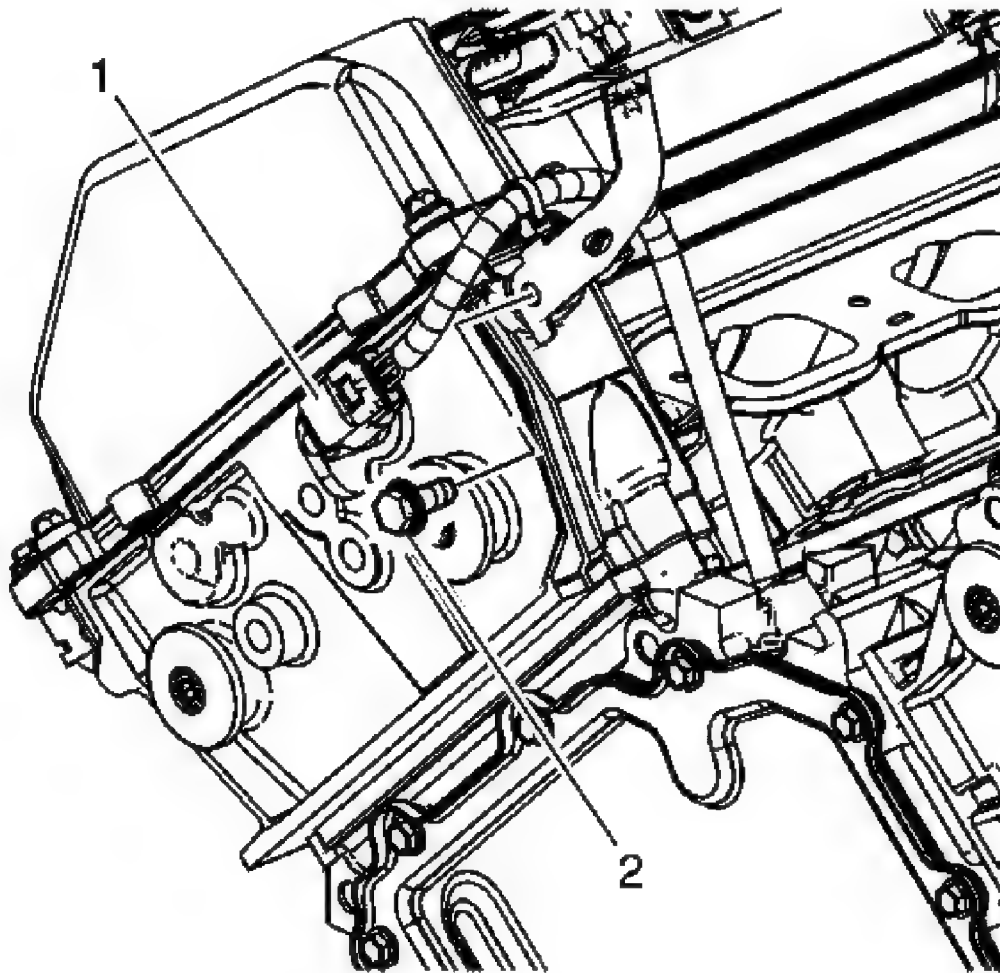


Fig. 105: Identifying Crankshaft Position Sensor & Wiring Harness
Courtesy of GENERAL MOTORS CORP.

20. Connect the crankshaft position sensor wiring harness (1) to the CMP sensor.
21. Install the jumping ground bracket bolt (2) to the right cylinder head.

Tighten: Tighten the jumping ground bracket bolt (2) to 20 N.m (15 lb ft).

WATER CROSSOVER INSTALLATION

INSTALLATION PROCEDURE

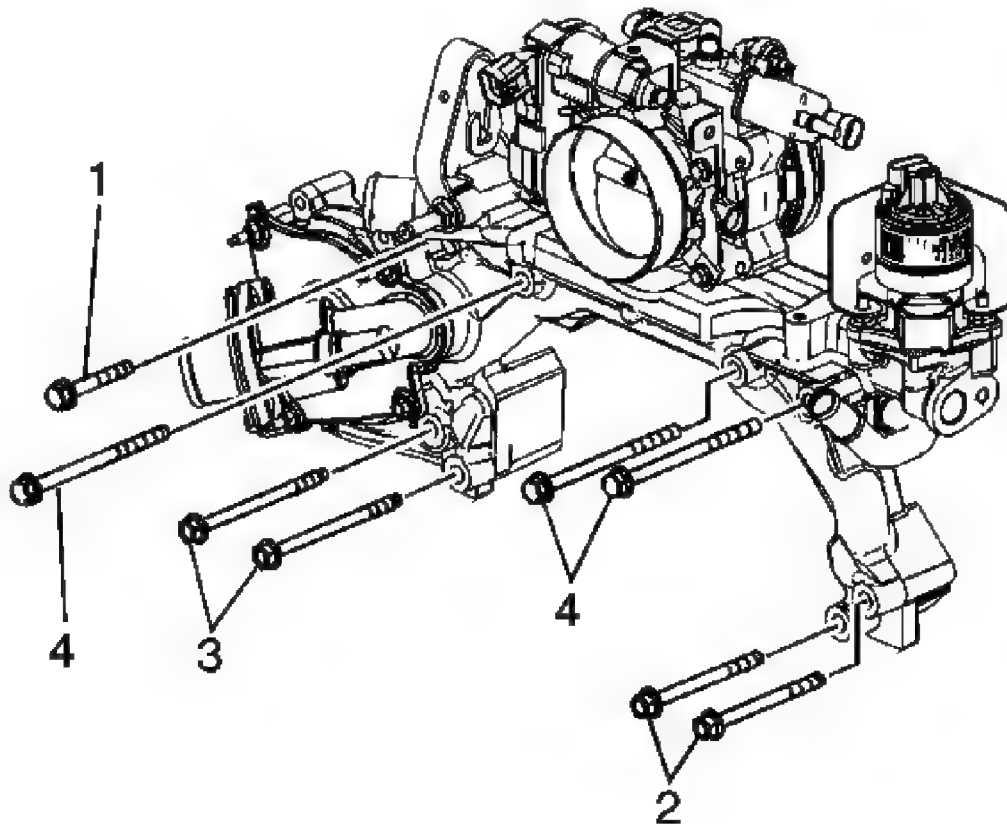


Fig. 106: Identifying Water Pump Housing & Bolts
Courtesy of GENERAL MOTORS CORP.

1. With the water crossover on the bench, install all eight crossover bolts in locations as shown.
 - Bolt (1) length 40.7 mm (1.6024 in)
 - Bolts (2) length 92.0 mm (3.6220 in)
 - Bolts (3) length 109.0 mm (4.2913 in)
 - Bolts (4) length 115.0 mm (4.5276 in)

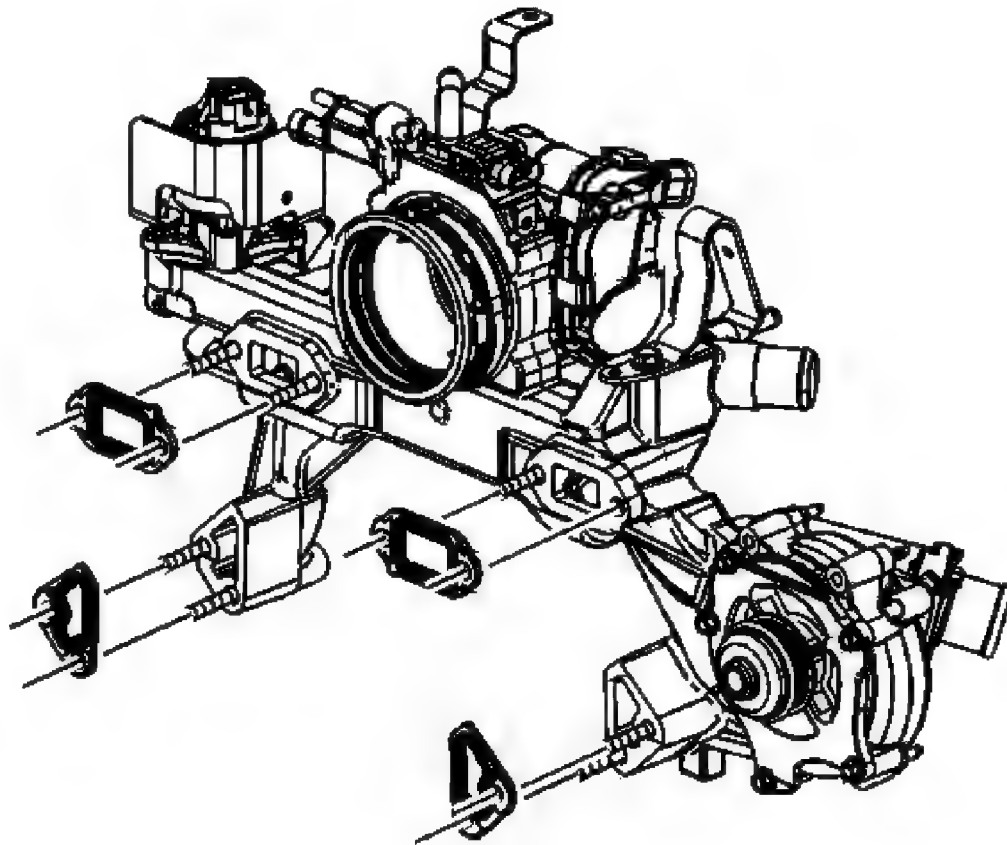


Fig. 107: Removing/Installing Water Pump Housing Gaskets & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Slide the upper and lower water crossover gaskets onto the bolts with the crossover still on the bench.

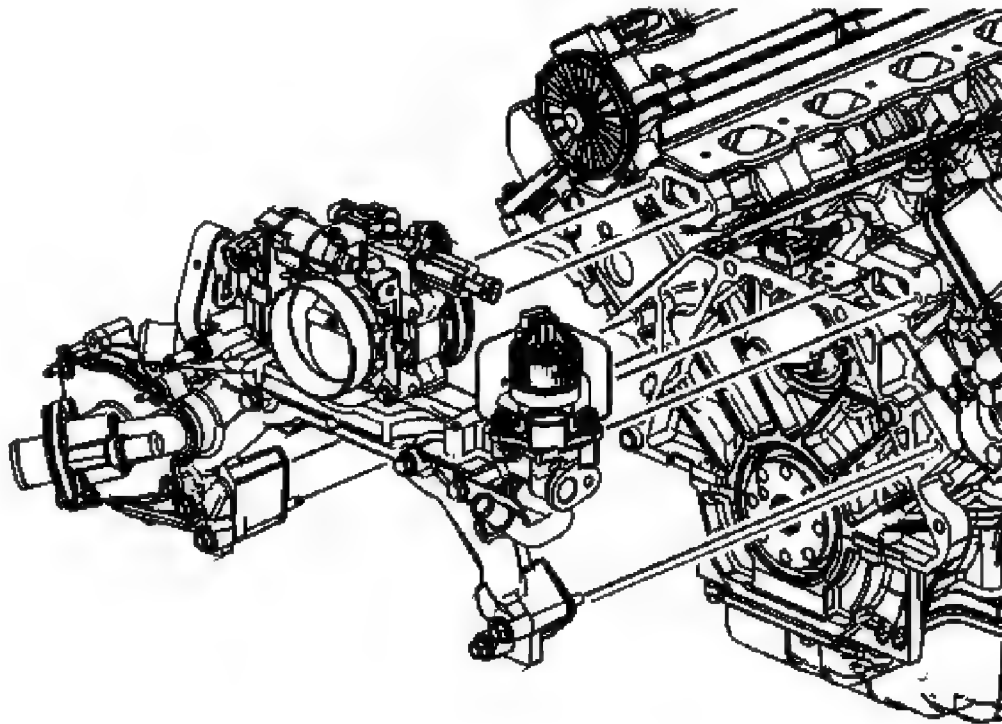


Fig. 108: View Of Water Pump Housing
Courtesy of GENERAL MOTORS CORP.

3. Place the water crossover in position and hand start the bolts to hold the crossover in place.

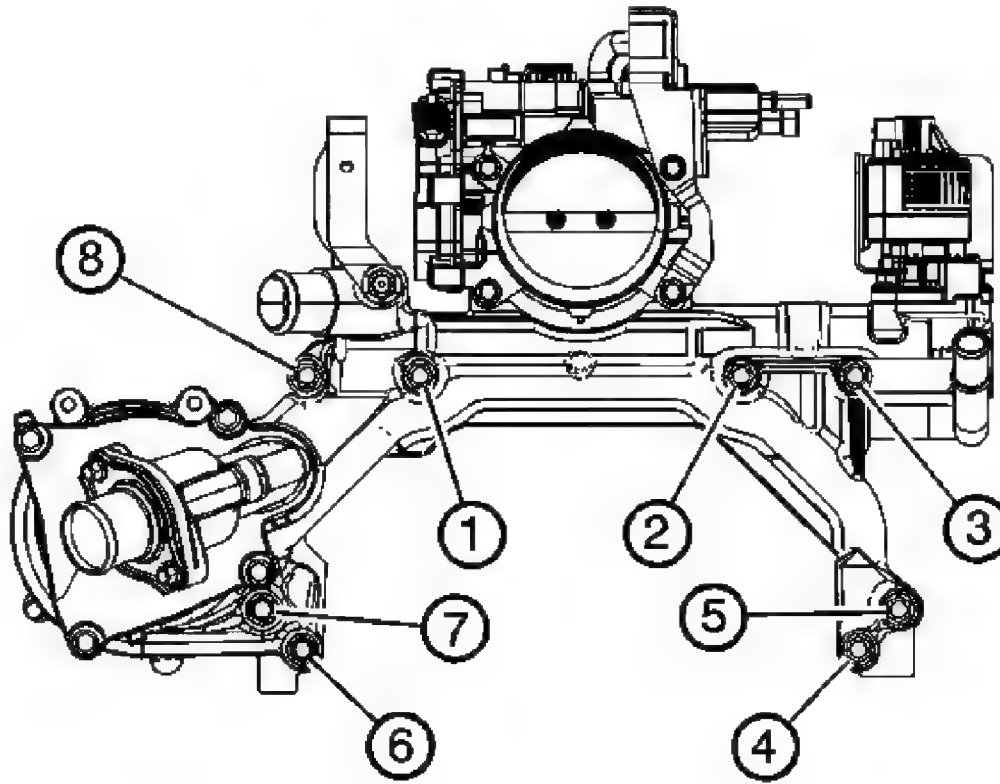


Fig. 109: Identifying Water Crossover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

4. Tighten the water crossover bolts in sequence (1-8).

Tighten: Tighten all water crossover bolts to 25 N.m (18 lb ft).

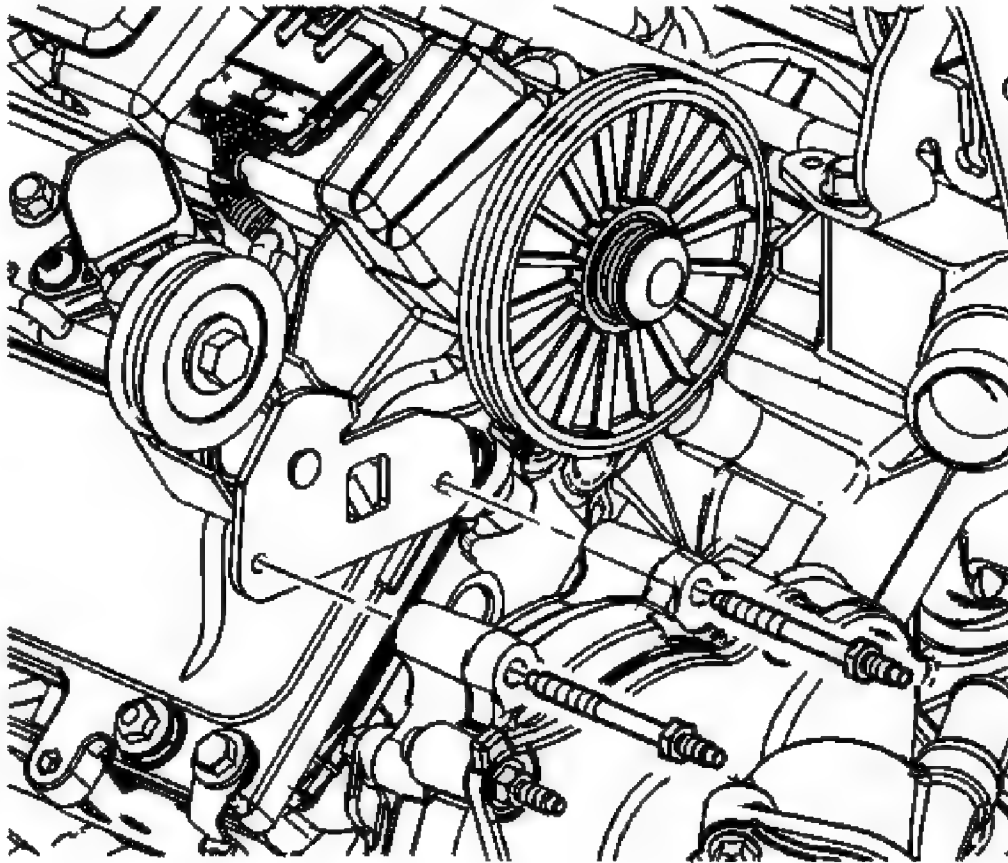


Fig. 110: Identifying Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

5. Place the water pump drive belt tensioner in position on the water pump housing.
6. Install the water pump drive belt tensioner bolts.

Tighten: Tighten the drive belt tensioner bolts to 10 N.m (89 lb in).

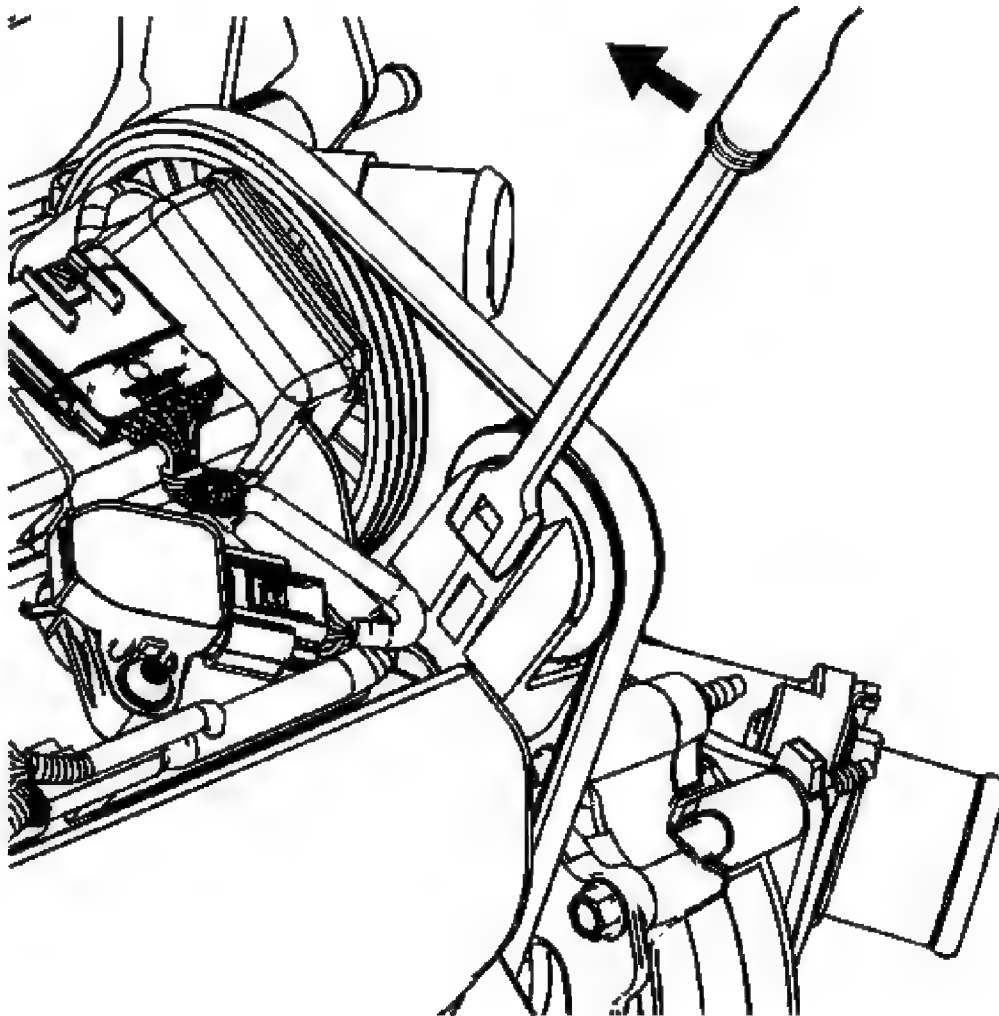


Fig. 111: Rotating Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Feed the water pump drive belt around the water pump pulley and the water pump drive belt tensioner.
8. Compress the drive belt tensioner. Feed the drive belt around the drive pulley.
9. Check the drive belt for proper seating in all the pulley grooves.

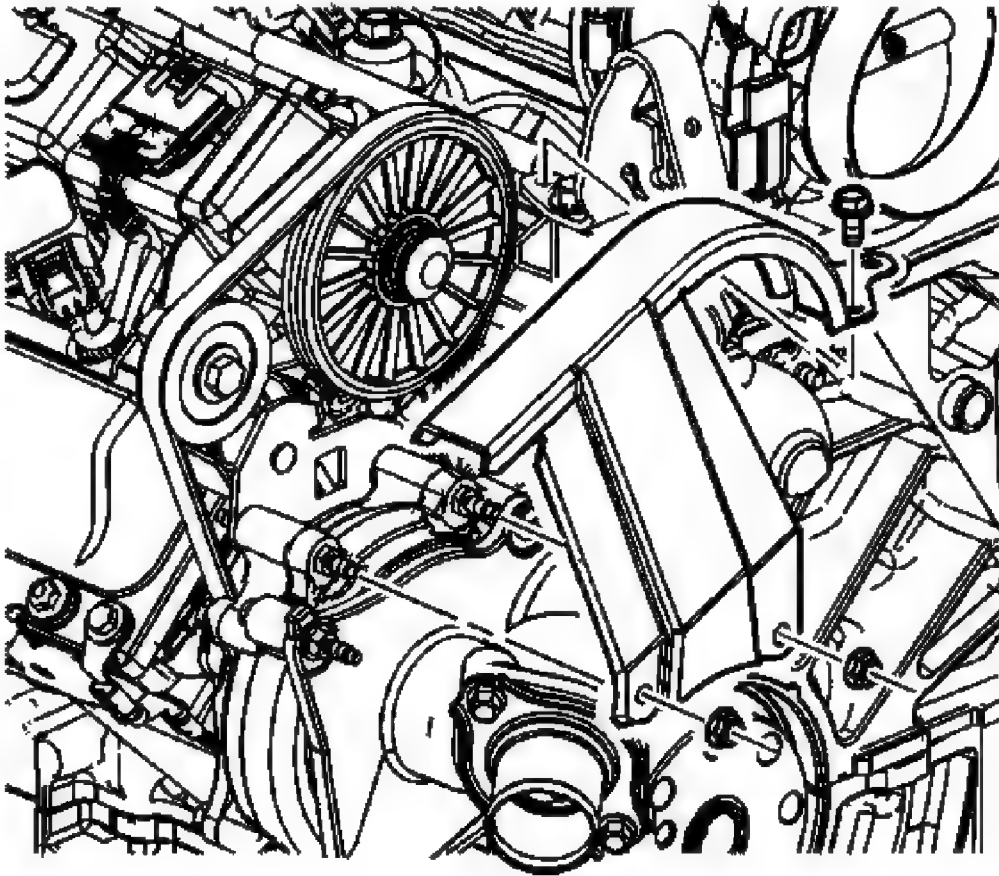


Fig. 112: Identifying Water Pump Drive Belt Shield Bolt & Nuts
Courtesy of GENERAL MOTORS CORP.

10. Place the water pump drive belt shield in position.
11. Hand start the water pump drive belt shield nuts on the studs.
12. Hand start the water pump drive belt shield bolt.
13. Tighten the water pump shield nuts and bolt.

Tighten:

1. Tighten the water pump shield nuts to 10 N.m (89 lb in).
2. Tighten the water pump shield bolt to 10 N.m (89 lb in).

INTAKE MANIFOLD INSTALLATION

INSTALLATION PROCEDURE

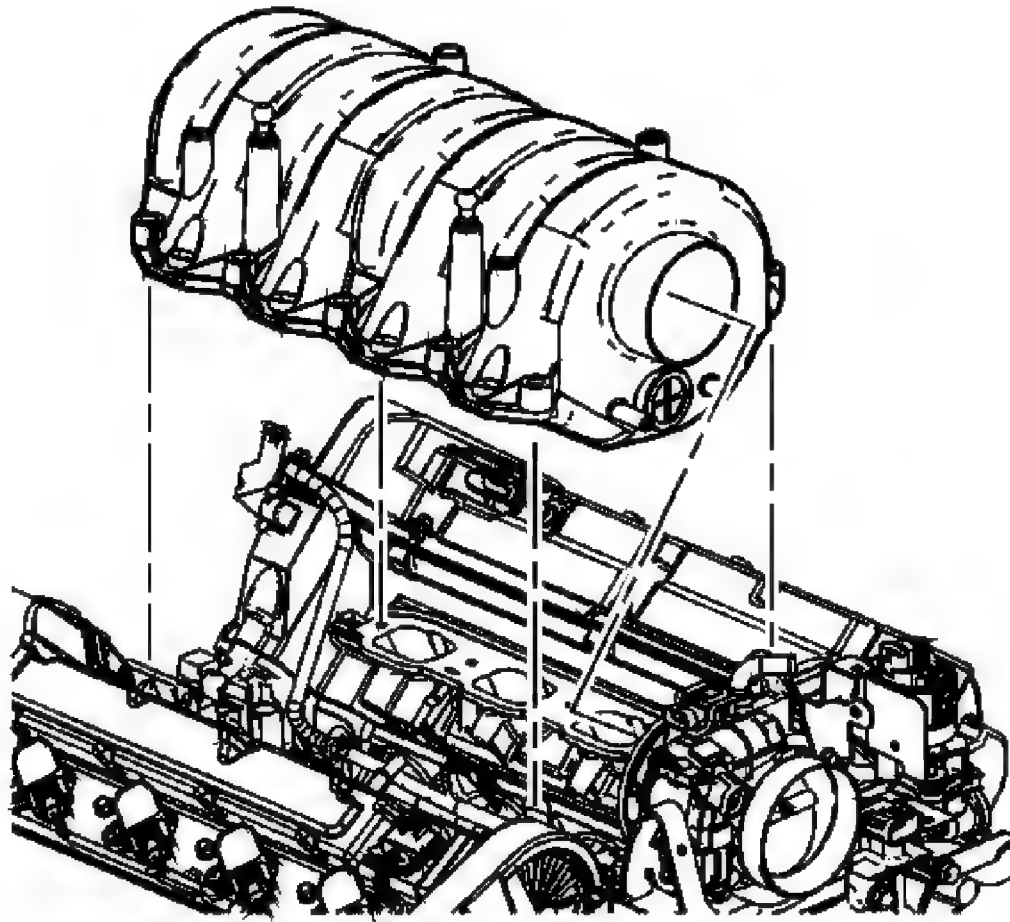


Fig. 113: View Of Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold, fitting the plenum duct over the intake manifold duct.

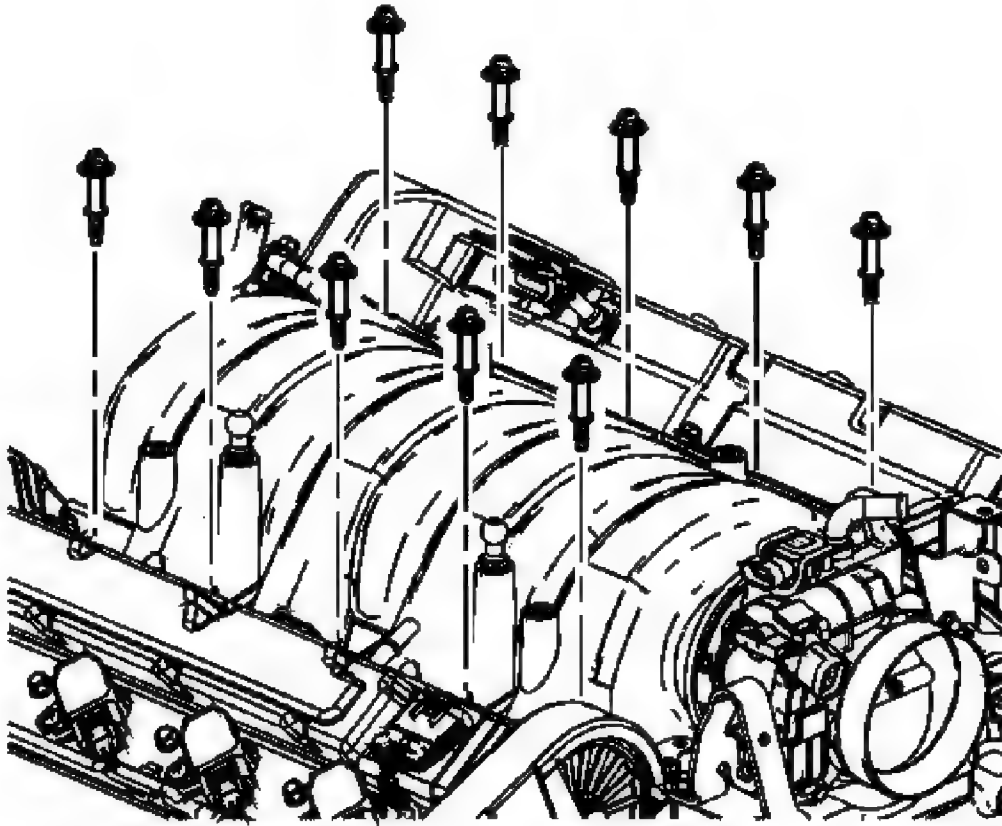


Fig. 114: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

2. Loosely install the intake manifold bolts.

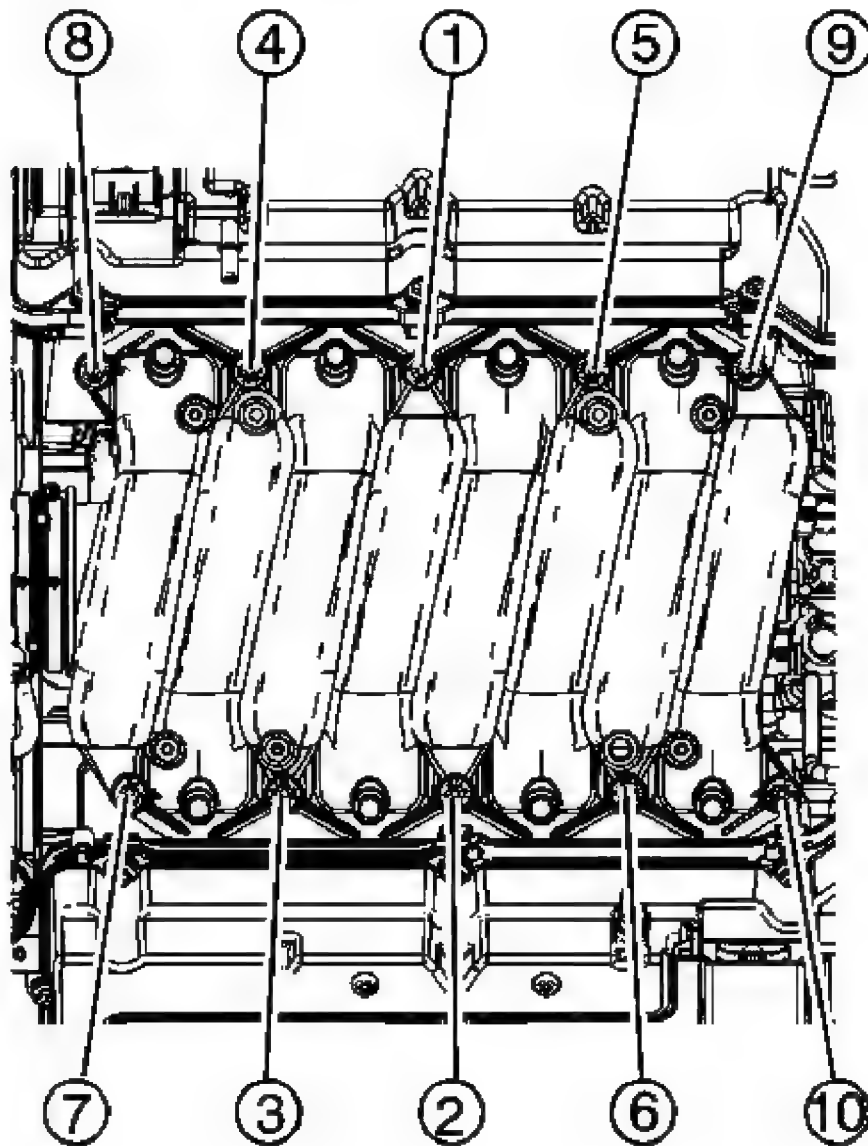


Fig. 115: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Tighten the intake manifold bolts in sequence (1-10).

Tighten: Tighten the intake manifold bolts to 10 N.m (89 lb in).

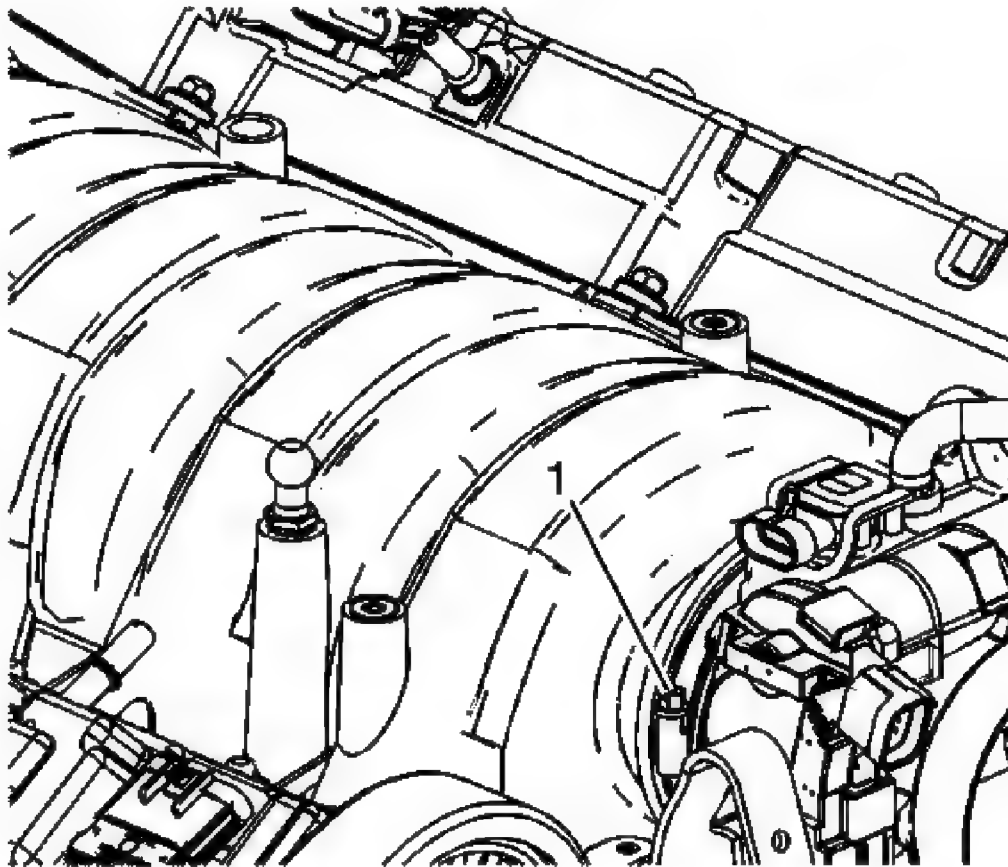


Fig. 116: Locating Plenum Duct Clamp
Courtesy of GENERAL MOTORS CORP.

4. Tighten the plenum duct clamp (1) to the intake manifold.

Tighten: Tighten the plenum duct clamp to 2.75 N.m (24 lb in).

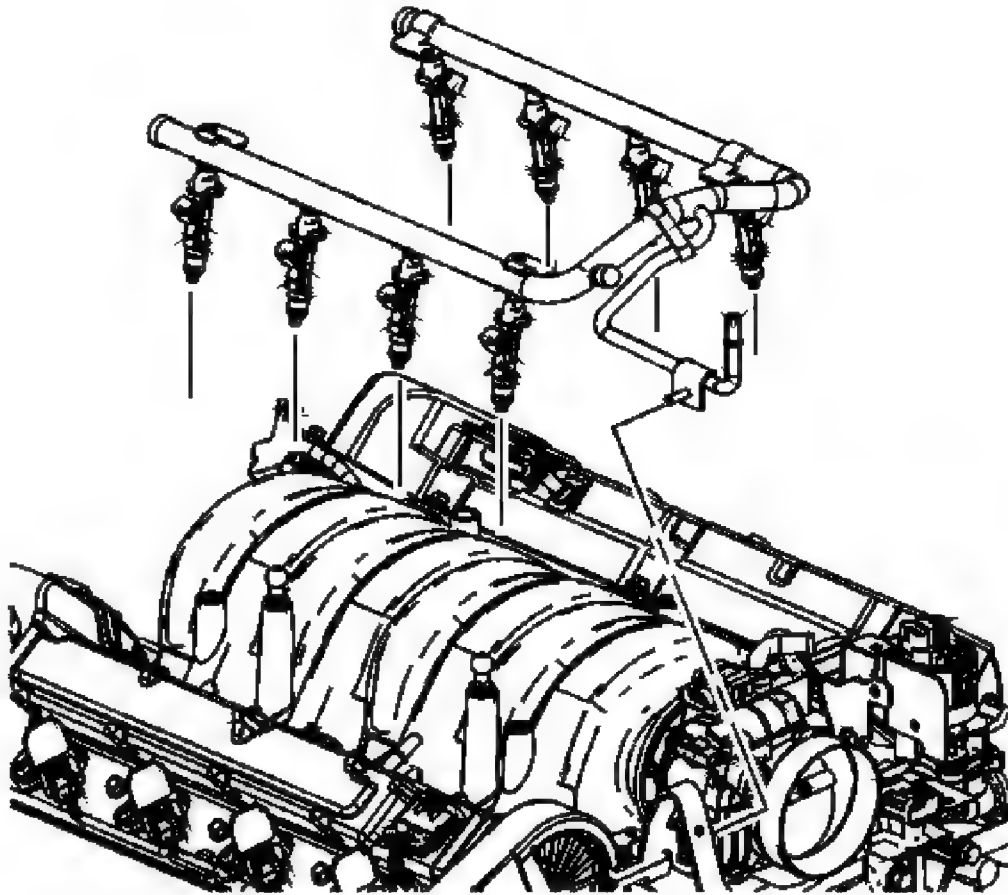


Fig. 117: Identifying Fuel Injectors & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

5. Inspect the fuel injector O-rings. Ensure the fuel injector O-rings are not missing, misaligned or damaged. Replace the O-rings if necessary.
6. Lubricate the intake manifold fuel injector bores with light mineral oil GM P/N 9981704, clean engine oil or equivalent.
7. Install the fuel rail with fuel injectors as an assembly.

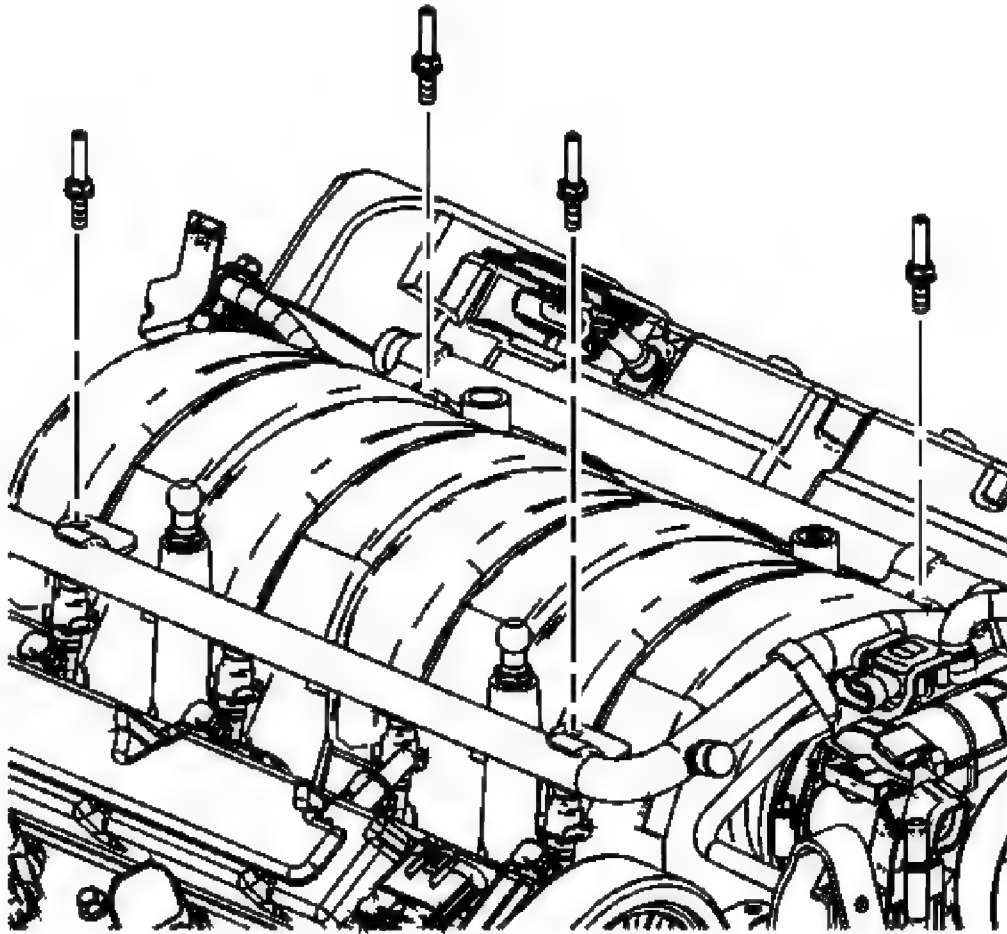


Fig. 118: Identifying Fuel Rail Studs
Courtesy of GENERAL MOTORS CORP.

8. Install the fuel rail studs.

Tighten: Tighten the fuel rail studs to 9 N.m (80 lb in).

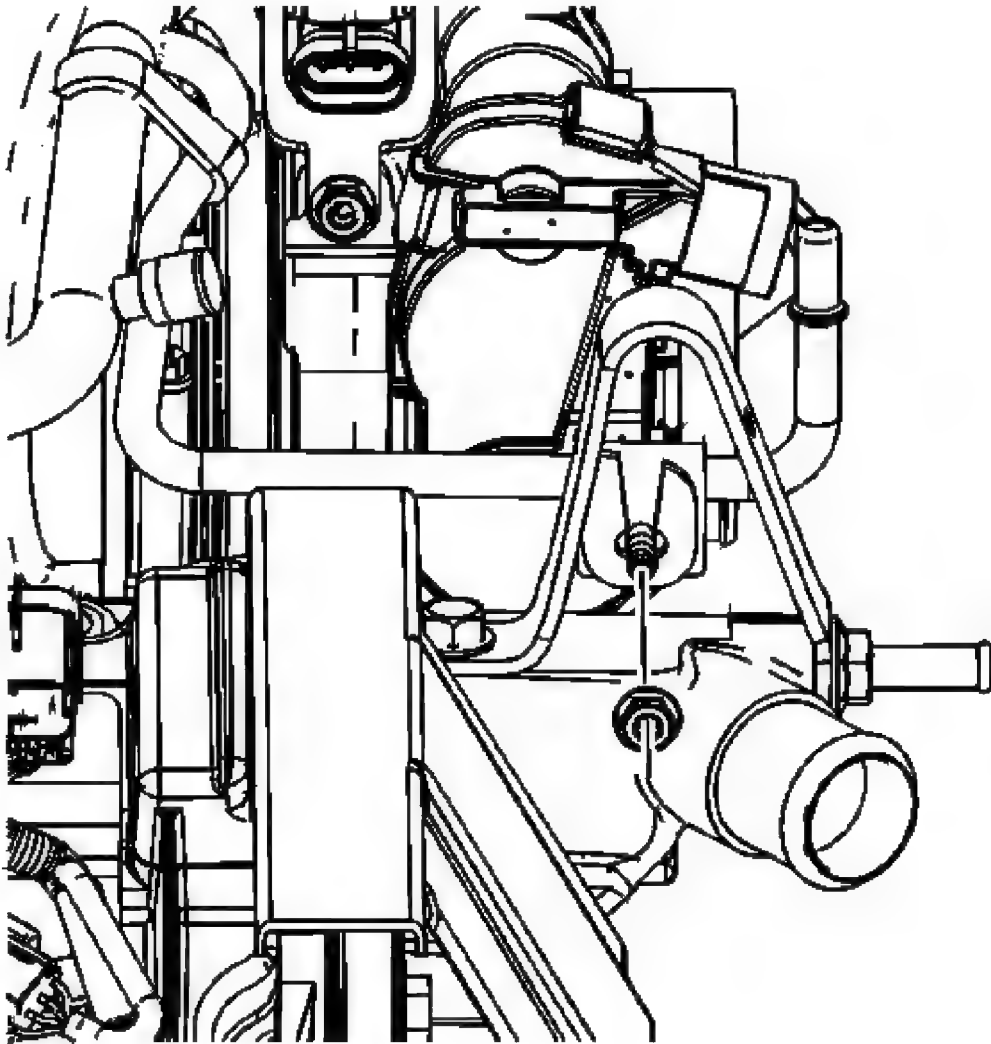


Fig. 119: Identifying Fuel Rail Bracket
Courtesy of GENERAL MOTORS CORP.

9. Install the fuel rail bracket nut to the fuel rail stud at the engine lift bracket on the water crossover.

Tighten: Tighten the fuel rail bracket nut to 10 N.m (89 lb in).

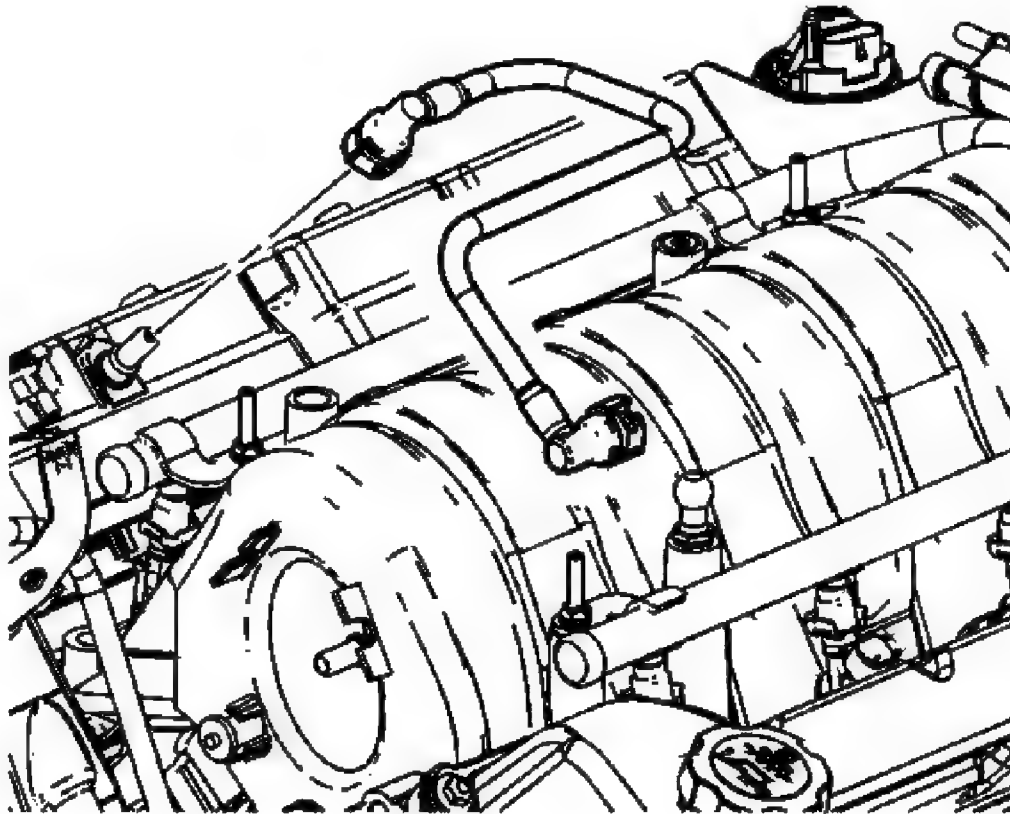


Fig. 120: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

10. Install the PCV dirty air tube to the PCV orifice in the right camshaft cover and to the intake manifold.

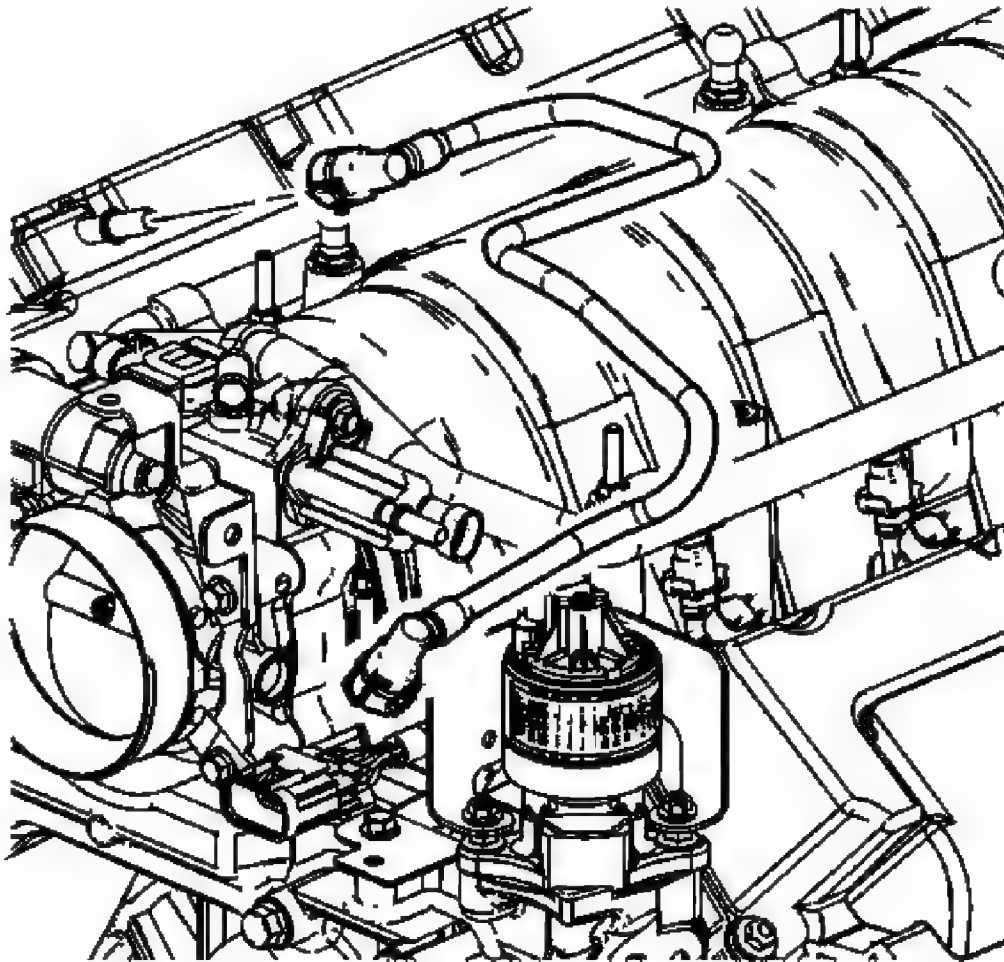


Fig. 121: Identifying PCV Fresh Air Feed Tube
Courtesy of GENERAL MOTORS CORP.

11. Install the PCV fresh air feed tube to the camshaft cover and the water crossover.

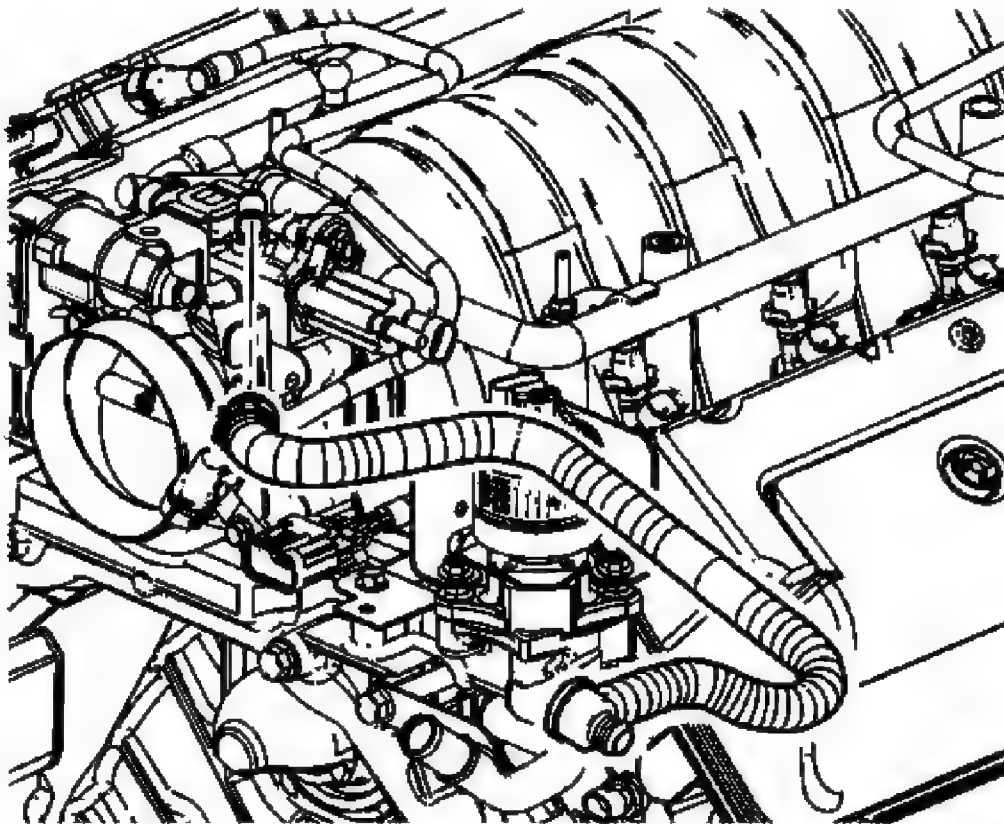


Fig. 122: Identifying Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

12. Install the brake booster hose to the vacuum fitting in the water crossover.

OIL FILTER ADAPTER INSTALLATION (WITHOUT OIL COOLER)

INSTALLATION PROCEDURE

1. Install NEW O-ring seals in the oil filter adapter.

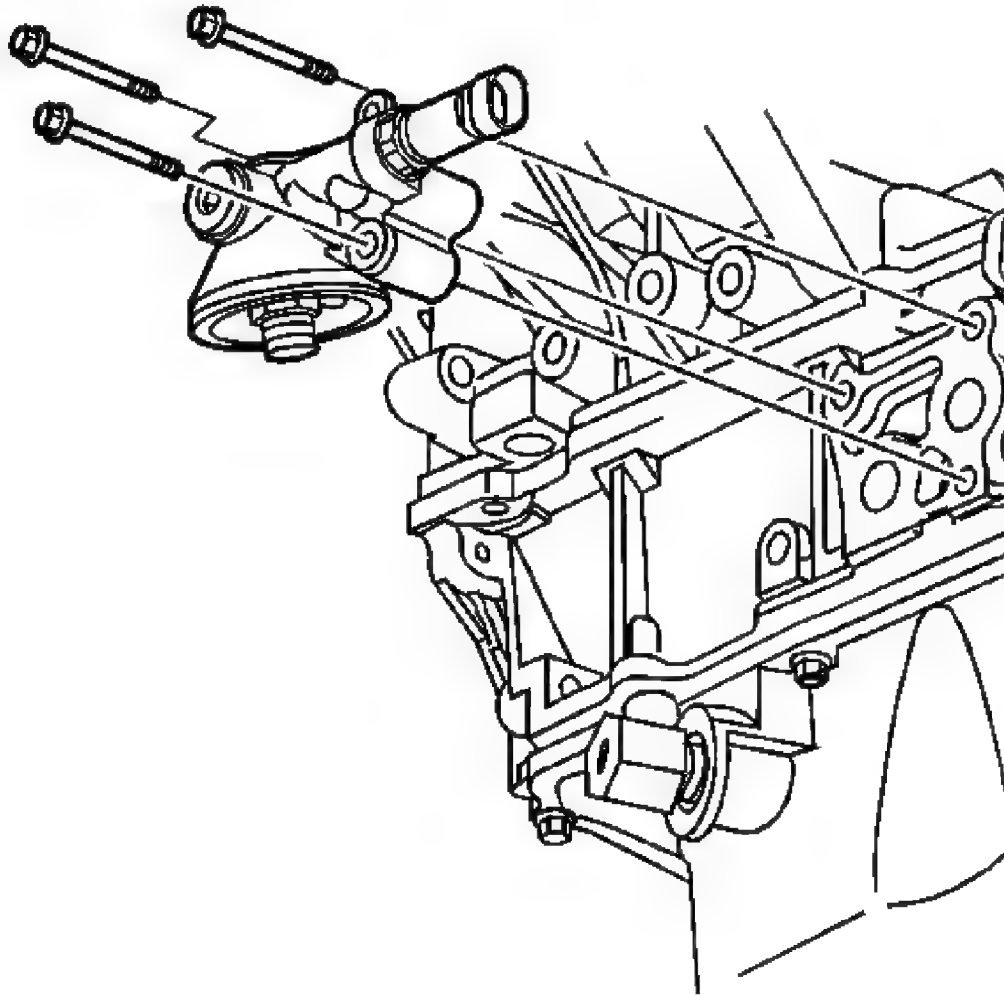


Fig. 123: View Of Oil Filter Adapter & Bolts (without Oil Cooler)
Courtesy of GENERAL MOTORS CORP.

2. Position the oil filter adapter on the crankcase.

NOTE: Refer to Fastener Notice .

3. Install the oil filter adapter bolts.

Tighten: Tighten the oil filter adapter bolts to 25 N.m (18 lb ft).

4. Install the oil pressure sensor.

Tighten: Tighten the oil pressure sensor to 16 N.m (12 lb ft).

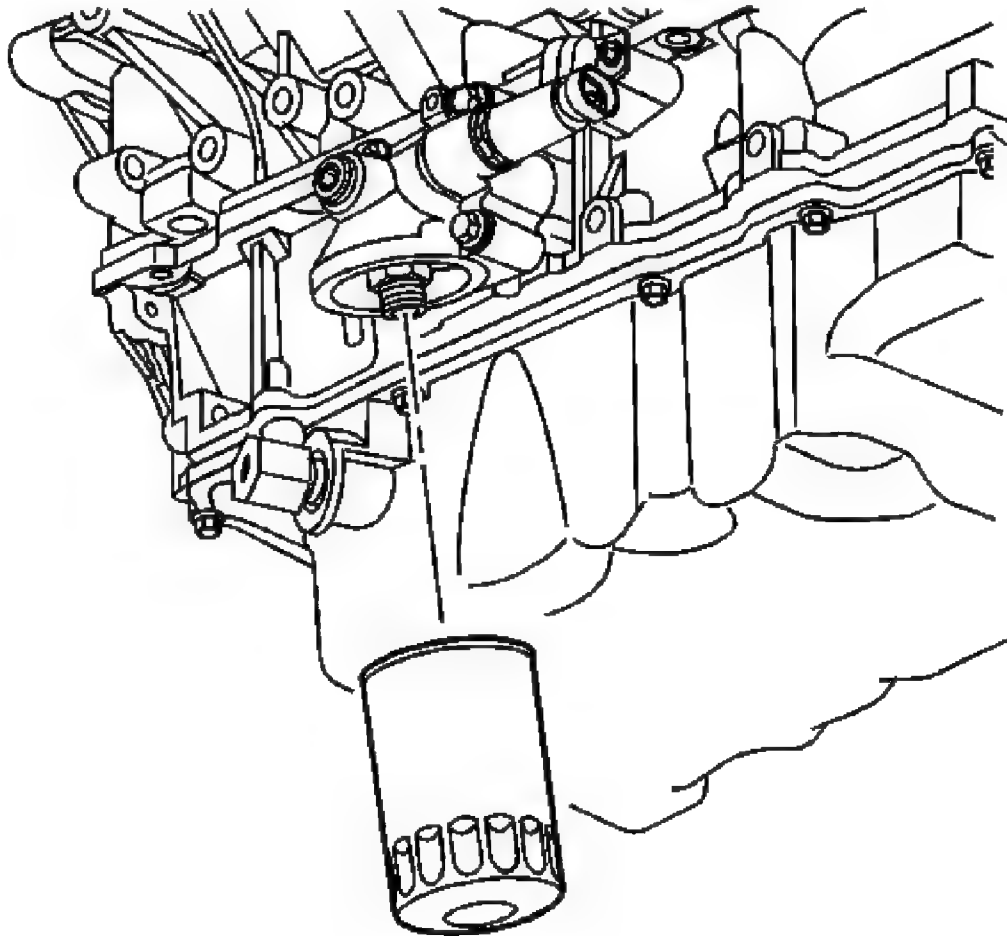


Fig. 124: View Of Oil Filter (without Oil Cooler)
Courtesy of GENERAL MOTORS CORP.

5. Fill the oil filter with oil.
6. Install the oil filter.

Tighten: Tighten the oil filter to 32 N.m (24 lb ft).

OIL FILTER ADAPTER INSTALLATION (WITH OIL COOLER)

INSTALLATION PROCEDURE

1. Install NEW O-ring seals in the oil filter adapter.

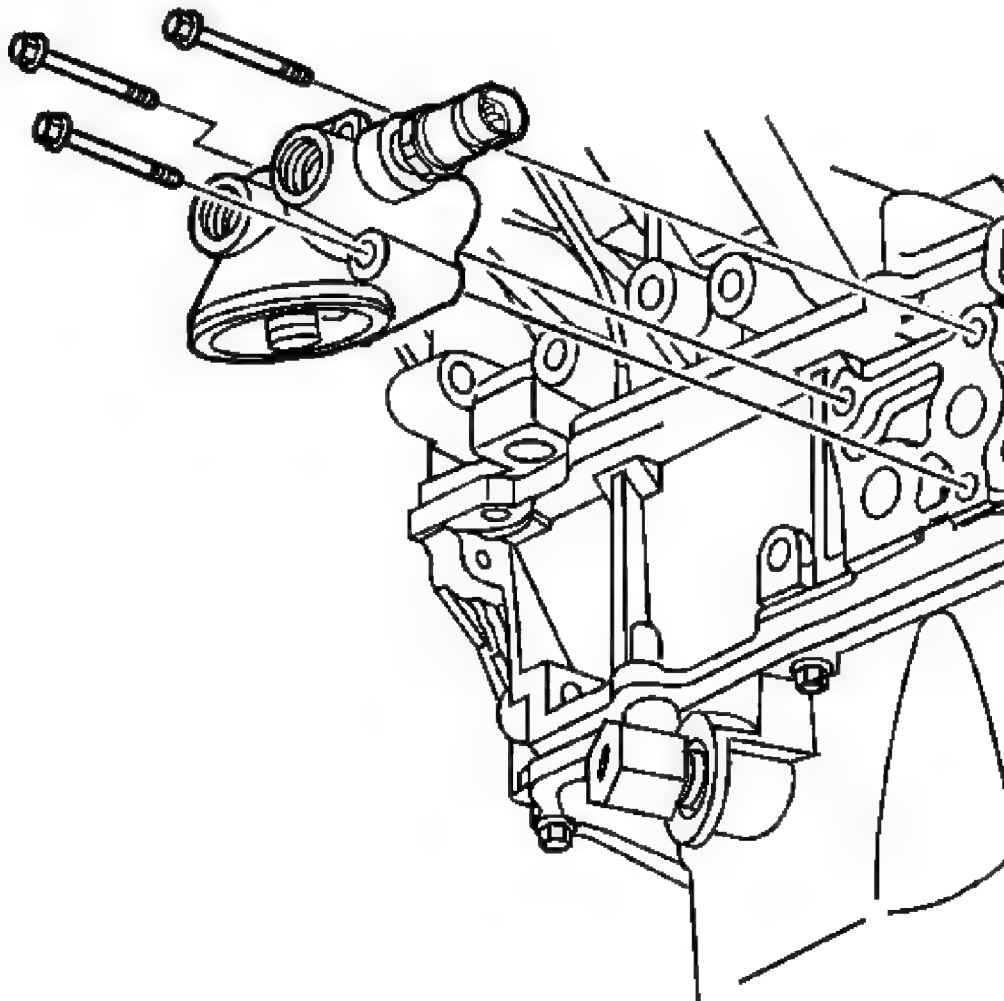


Fig. 125: Identifying Oil Filter Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

2. Position the oil filter adapter on the crankcase.

NOTE: Refer to Fastener Notice .

3. Install the oil filter adapter bolts.

Tighten: Tighten the oil filter adapter bolts to 25 N.m (18 lb ft).

4. Install the oil pressure sensor.

Tighten: Tighten the oil pressure sensor to 16 N.m (12 lb ft).

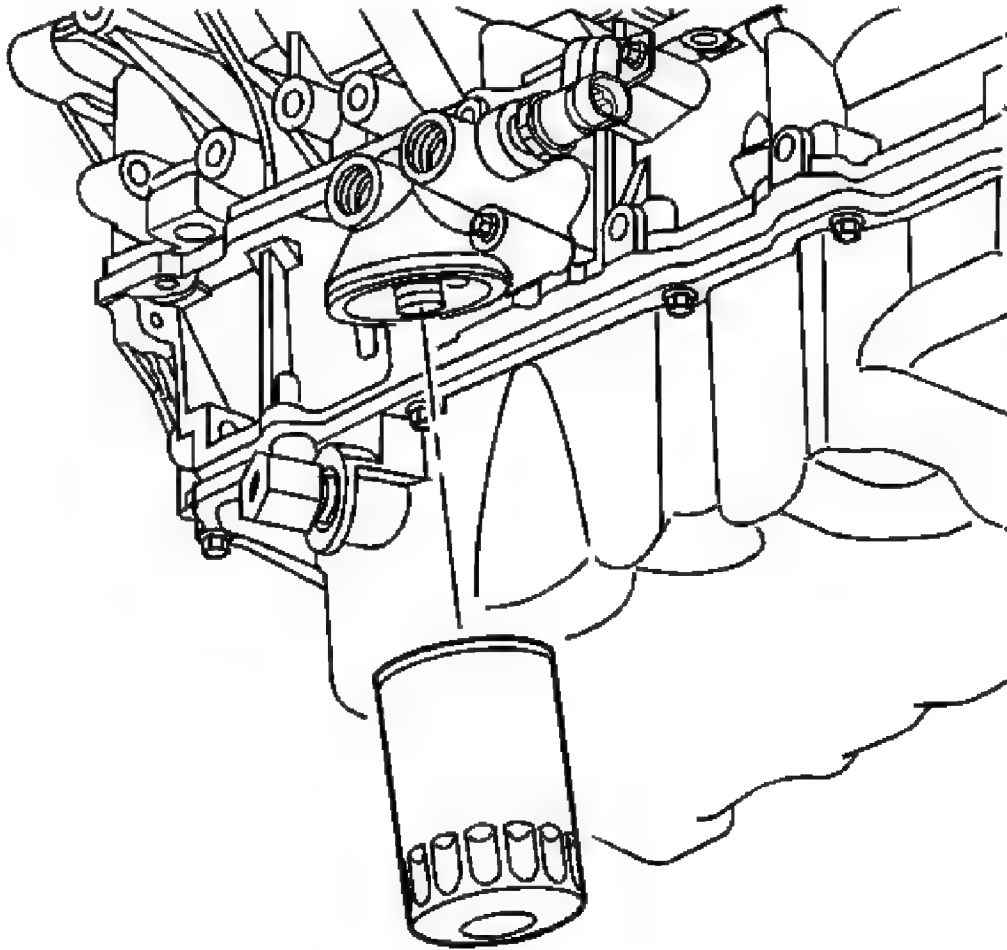


Fig. 126: View Of Oil Filter (with Oil Cooler)
Courtesy of GENERAL MOTORS CORP.

5. Fill the oil filter with oil.
6. Install the oil filter.

Tighten: Tighten the oil filter to 32 N.m (24 lb ft).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE (W/O RPO NC1 OR NF7)

INSTALLATION PROCEDURE

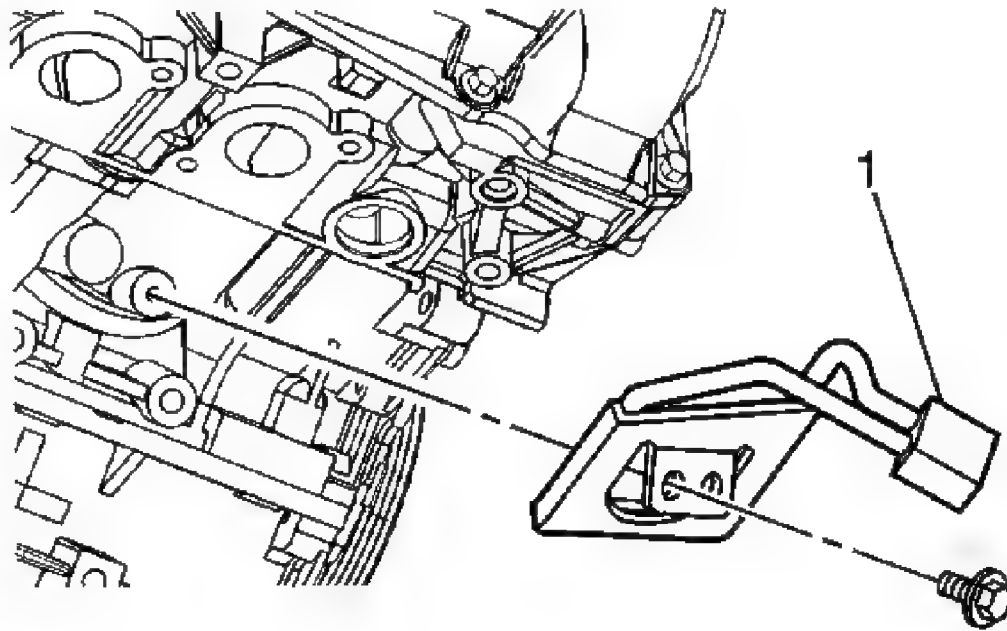


Fig. 127: Locating Right Side Coolant Heater
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. If the engine is equipped with coolant heaters, install the right side (1) heater as follows:
 1. Place the coolant heater (1) in position on the cylinder block.
 2. Install the coolant heater bolt.

Tighten: Tighten the coolant heater bolt to 10 N.m (89 lb in).

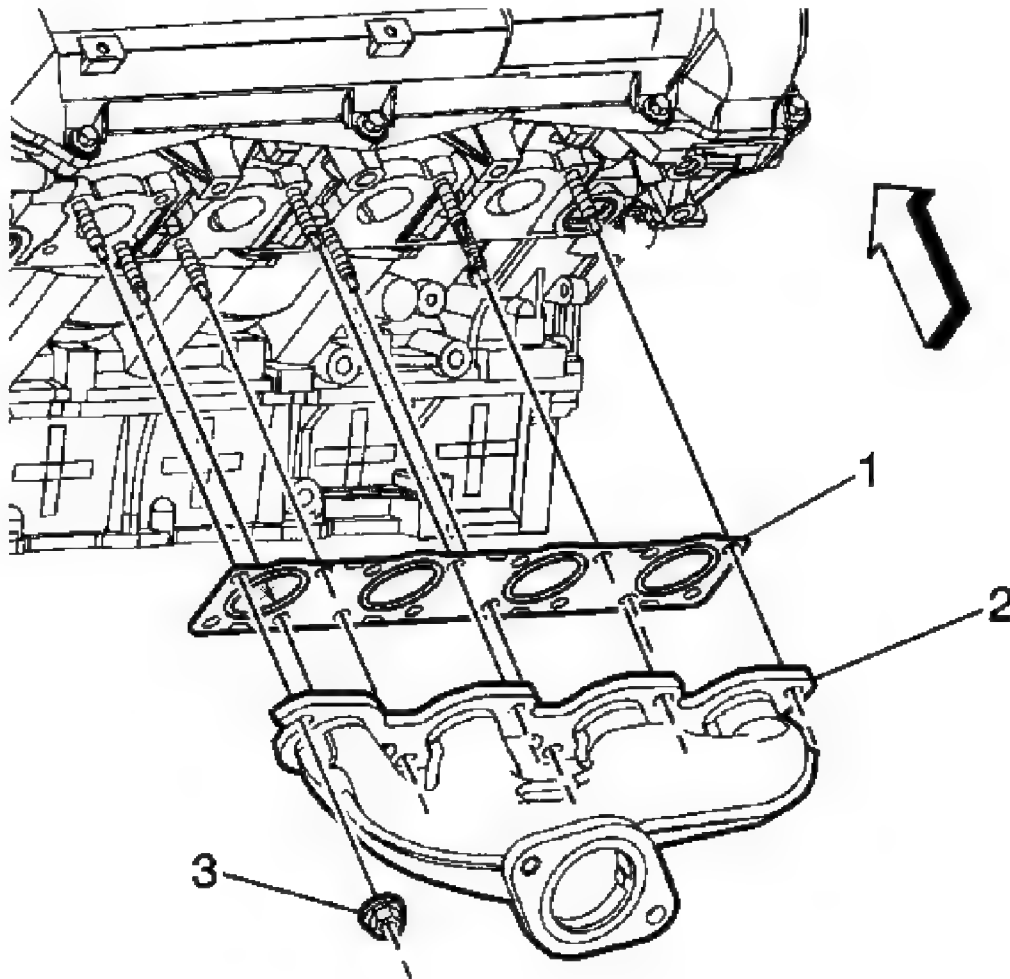


Fig. 128: Identifying Right Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

2. Position a new manifold gasket (1) in place on the cylinder head studs.
3. Using two hands, position the manifold (2) onto the cylinder head.
4. Install two outer manifold nuts (3) to hold the manifold in place.
5. Install the remaining manifold nuts.

Tighten: Tighten the exhaust manifold nuts (3) to 25 N.m (18 lb ft).

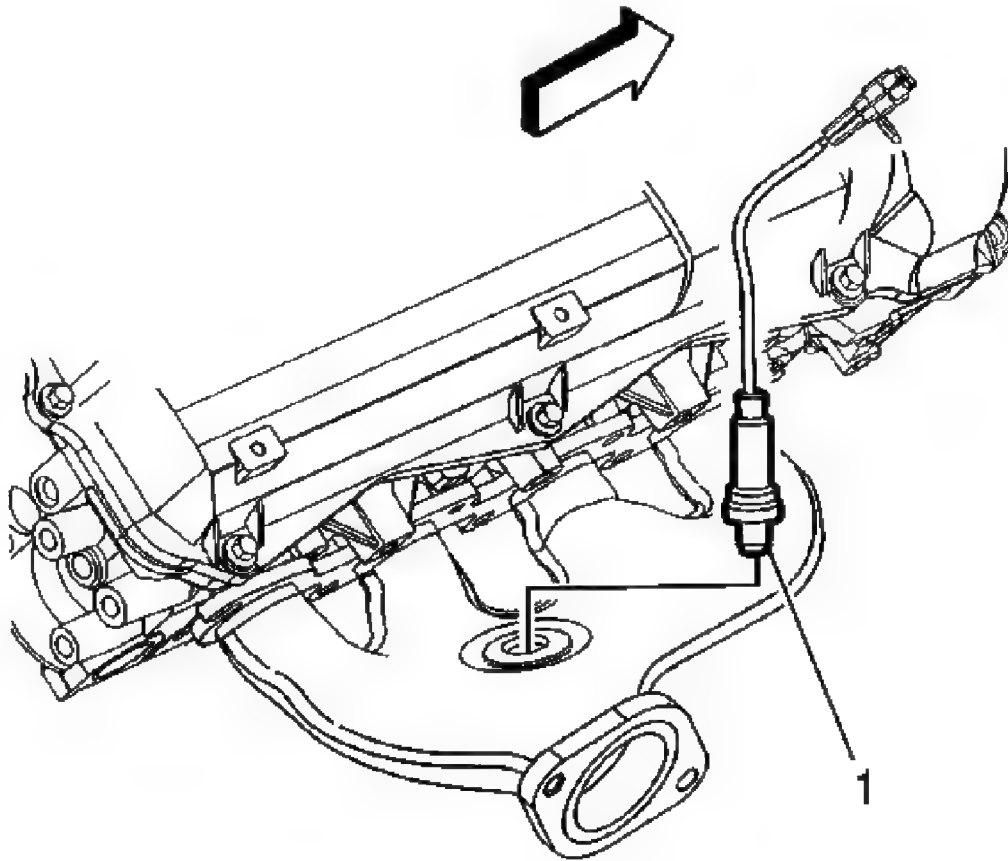


Fig. 129: View of Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

6. Coat the oxygen sensor threads with high temperature anti-seize, GM P/N 12377953 or equivalent.
7. Install the oxygen sensor (1).

Tighten: Tighten the oxygen sensor to 40 N.m (30 lb ft).

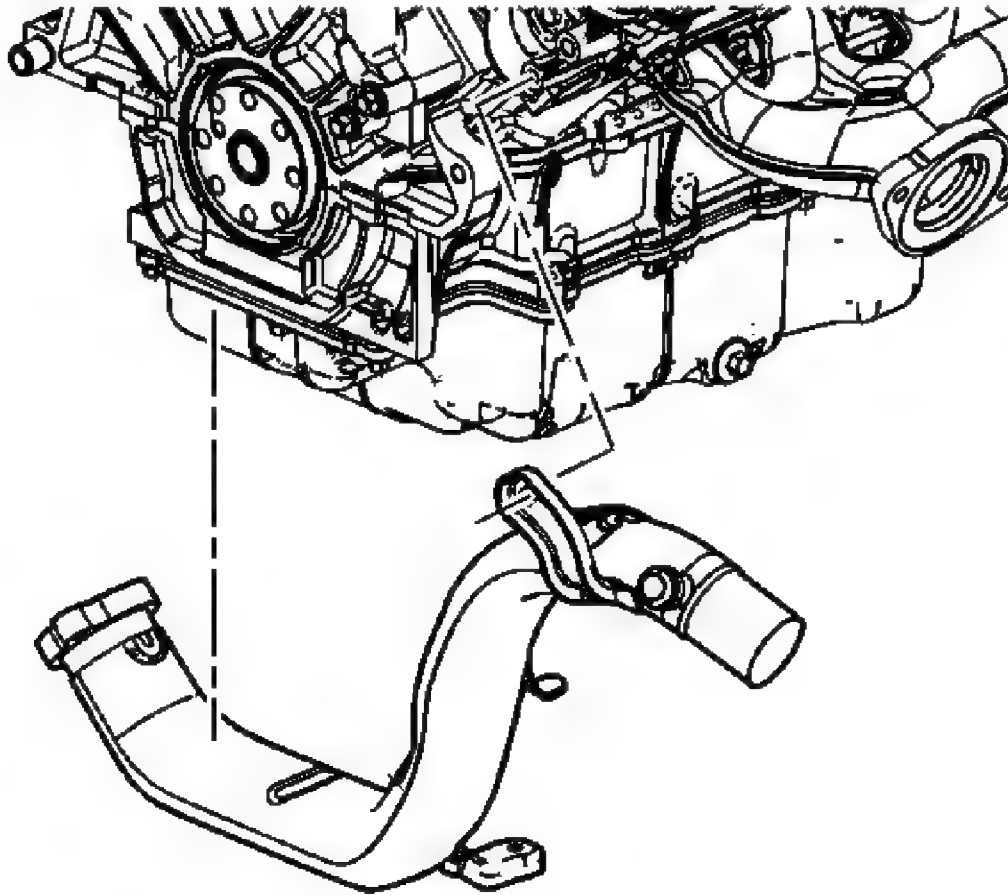


Fig. 130: Identifying Exhaust Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

8. Install the exhaust intermediate pipe.

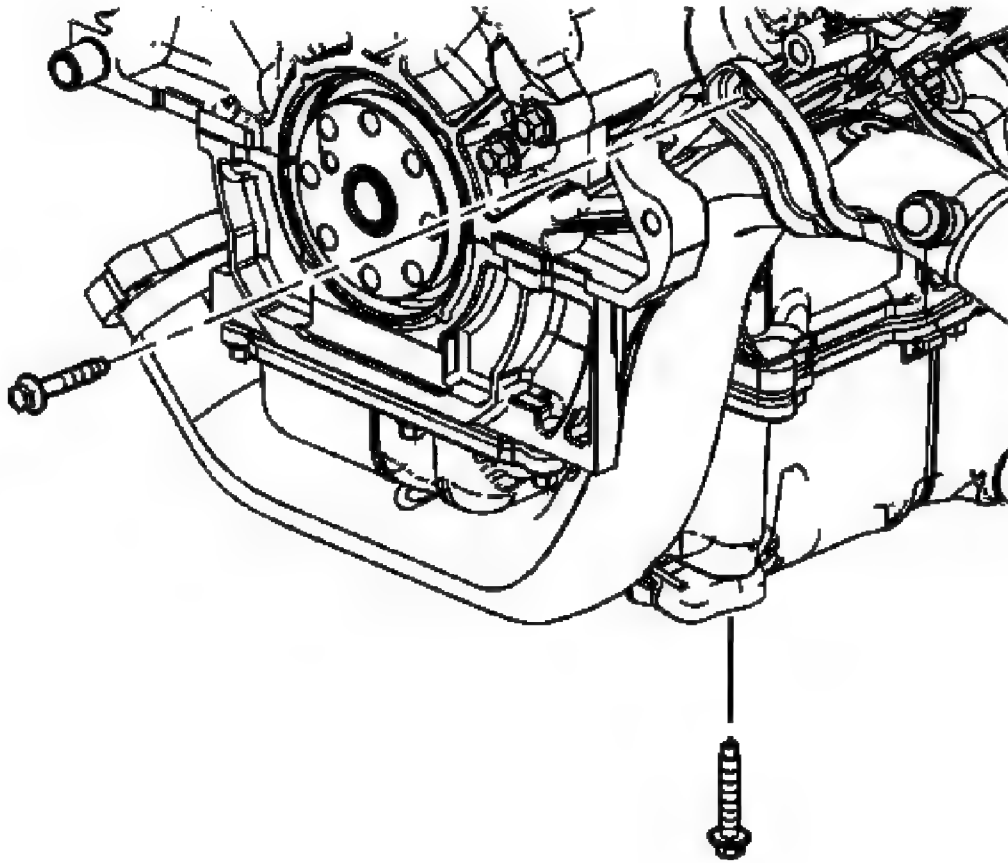


Fig. 131: View Of Exhaust Intermediate Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the exhaust intermediate pipe bolts.

Tighten: Tighten the exhaust intermediate pipe bolts to 30 N.m (22 lb ft).

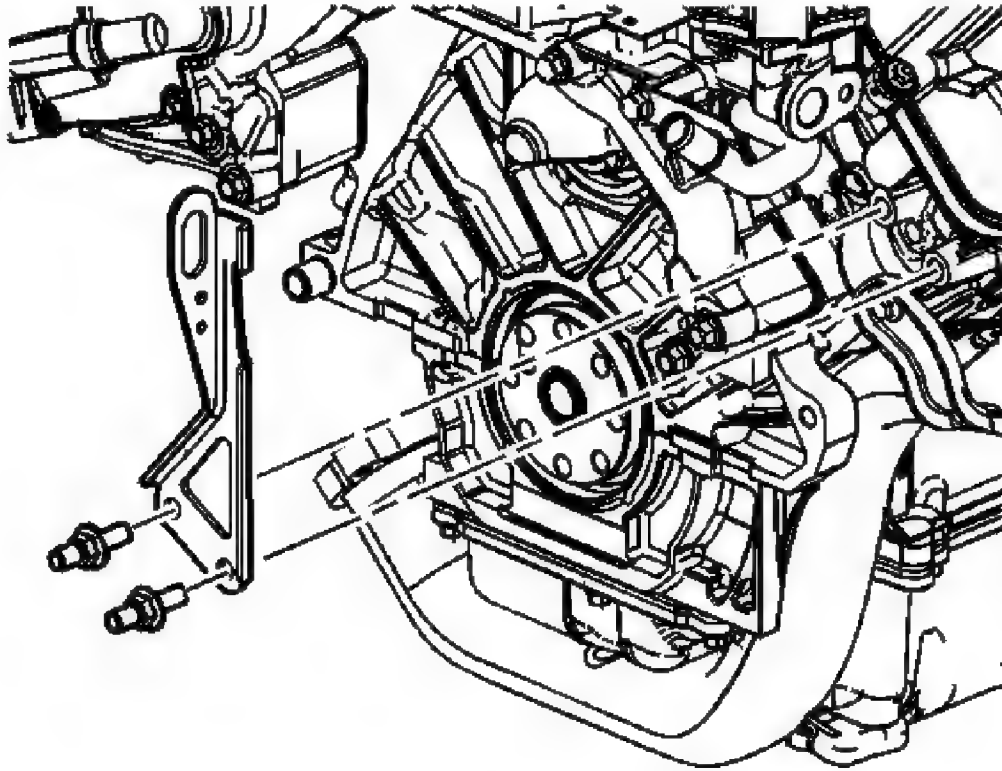


Fig. 132: Identifying Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS CORP.

10. Install the engine rear lift bracket.
11. Install the engine rear lift bracket bolts.

Tighten: Tighten the engine rear lift bracket bolts to 30 N.m (22 lb ft).

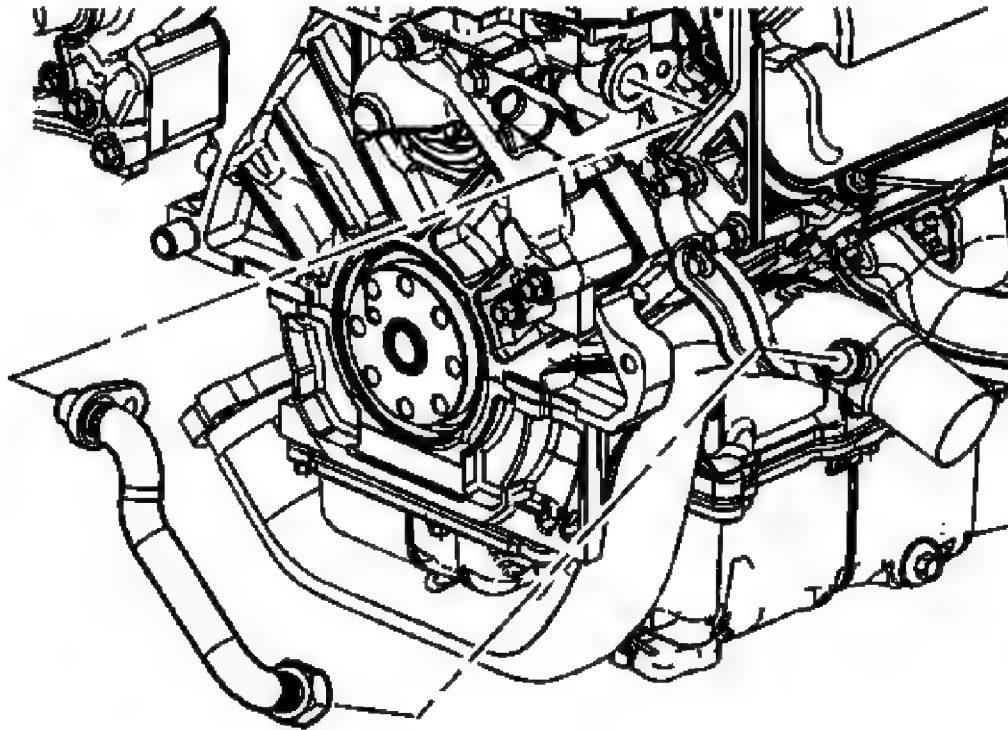


Fig. 133: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The exhaust gas recirculation (EGR) valve inlet pipe incorporates a crush seal connection at the water crossover. The EGR valve inlet pipe must be replaced if disconnected from the water crossover.

12. Install the NEW EGR valve inlet pipe into the water crossover port.

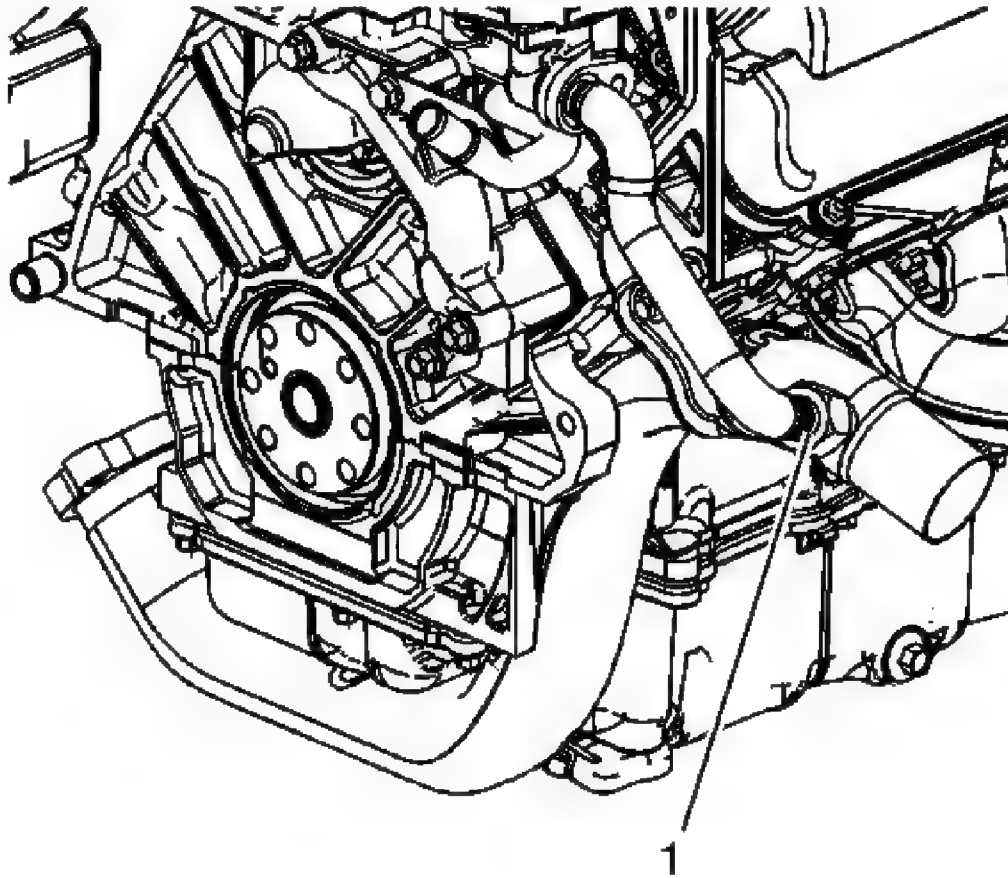


Fig. 134: Identifying EGR Valve Inlet Pipe Nut
Courtesy of GENERAL MOTORS CORP.

13. Loosely thread the EGR valve inlet pipe nut (1) onto the fitting on the exhaust intermediate pipe.

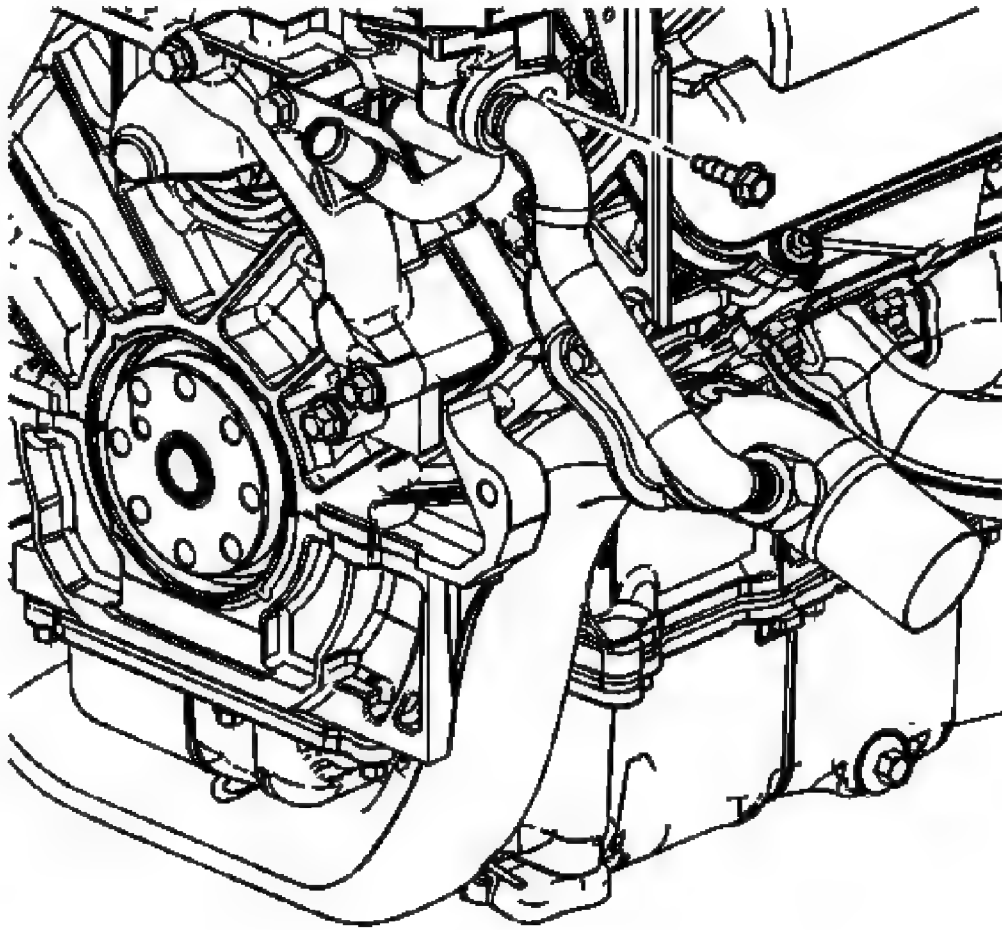


Fig. 135: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

14. Loosely thread the EGR valve inlet pipe bolt into the water crossover.
15. Tighten the EGR valve inlet pipe nut.

Tighten: Tighten the EGR valve inlet pipe nut to 60 N.m (44 lb ft).

16. Tighten the EGR valve inlet pipe bolt.

Tighten: Tighten the EGR valve inlet pipe bolt to 28 N.m (21 lb ft).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE (WITH RPO NC1 OR NF7)

INSTALLATION PROCEDURE

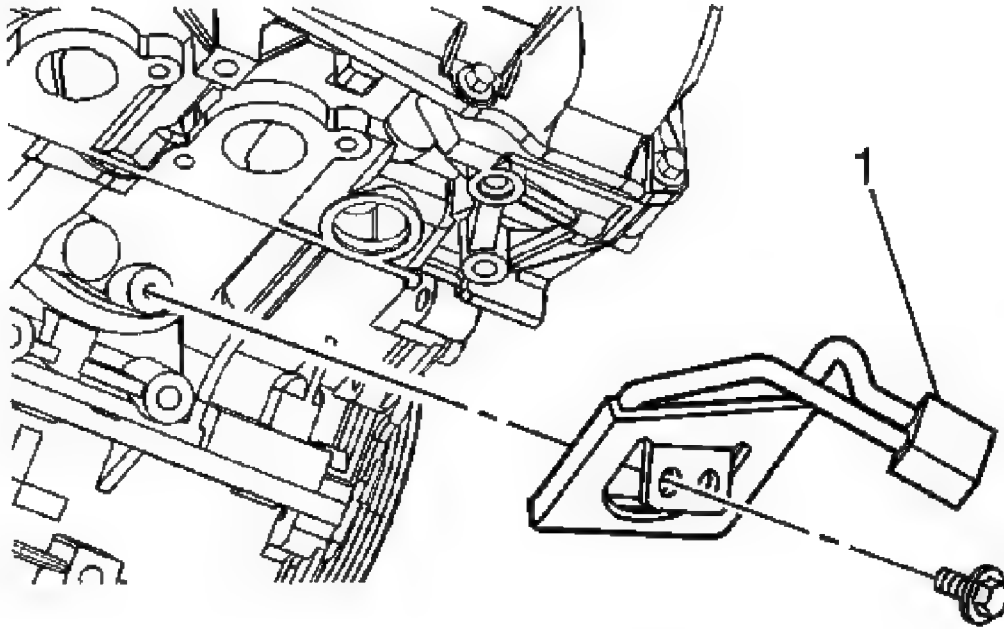


Fig. 136: Identifying Right Coolant Heater
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. If the engine is equipped with coolant heaters, install the right side (1) heater as follows:
 1. Place the coolant heater (1) in position on the cylinder block.
 2. Install the coolant heater bolt.

Tighten: Tighten the coolant heater bolt to 10 N.m (89 lb in).

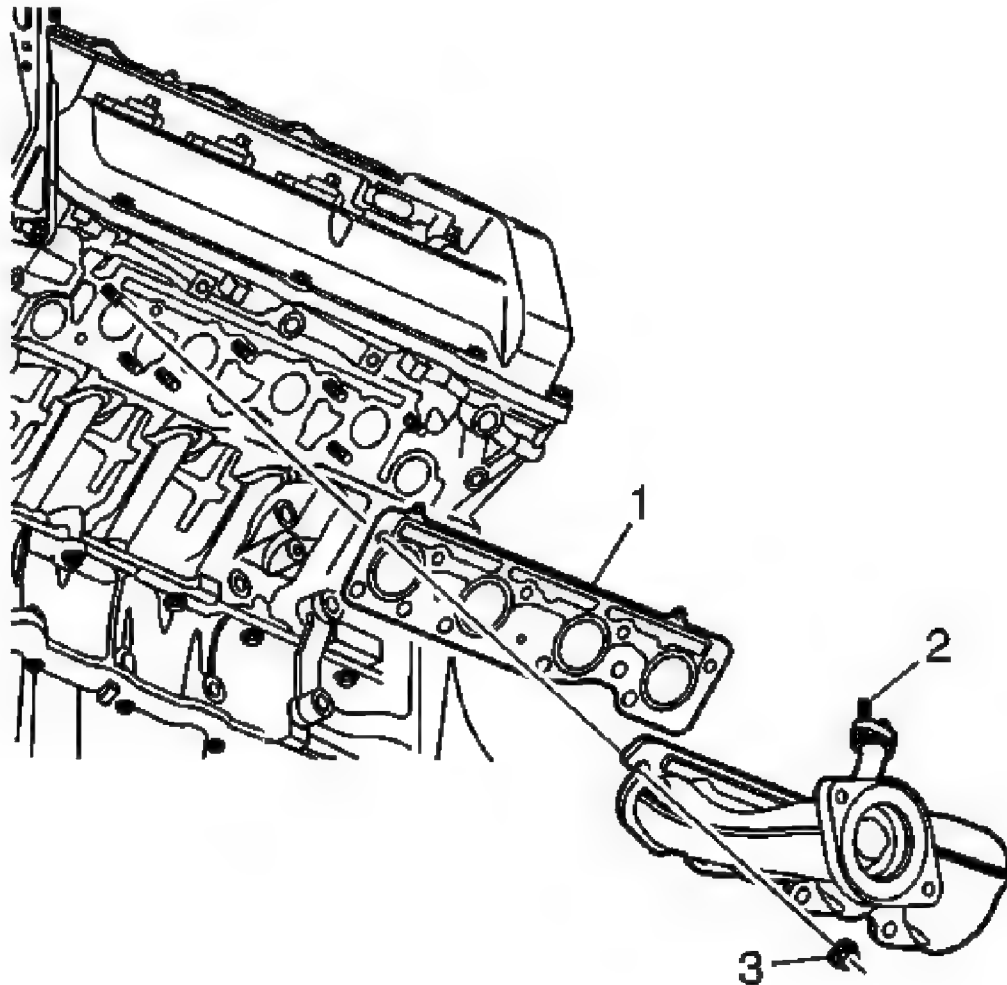


Fig. 137: View Of Right Exhaust Manifold, Gasket & Nuts (With RPO NC1 or NF7)

Courtesy of GENERAL MOTORS CORP.

2. Position a new manifold gasket (1) in place on the cylinder head studs.
3. Using two hands, position the manifold (2) onto the cylinder head.
4. Install two outer manifold nuts (3) to hold the manifold in place.
5. Install the remaining manifold nuts.

Tighten: Tighten the exhaust manifold nuts (3) to 25 N.m (18 lb ft).

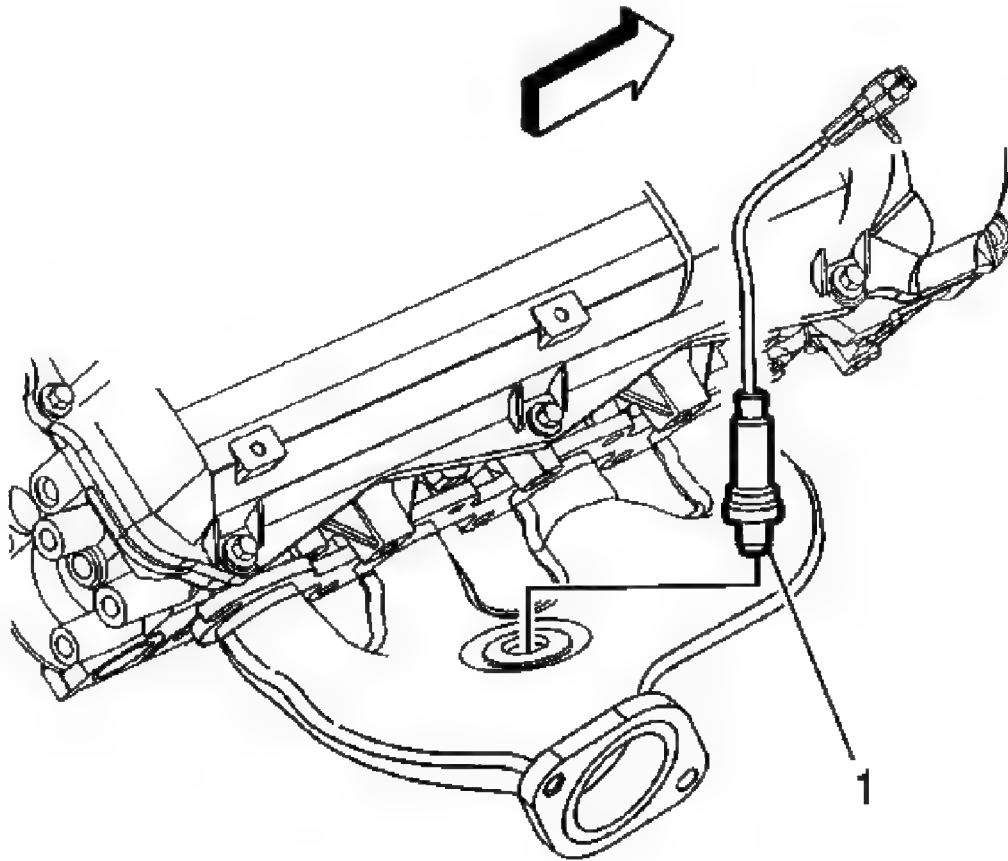


Fig. 138: View of Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

6. Coat the oxygen sensor threads with high temperature anti-seize, GM P/N 12377953 or equivalent.
7. Install the oxygen sensor (1).

Tighten: Tighten the oxygen sensor to 40 N.m (30 lb ft).

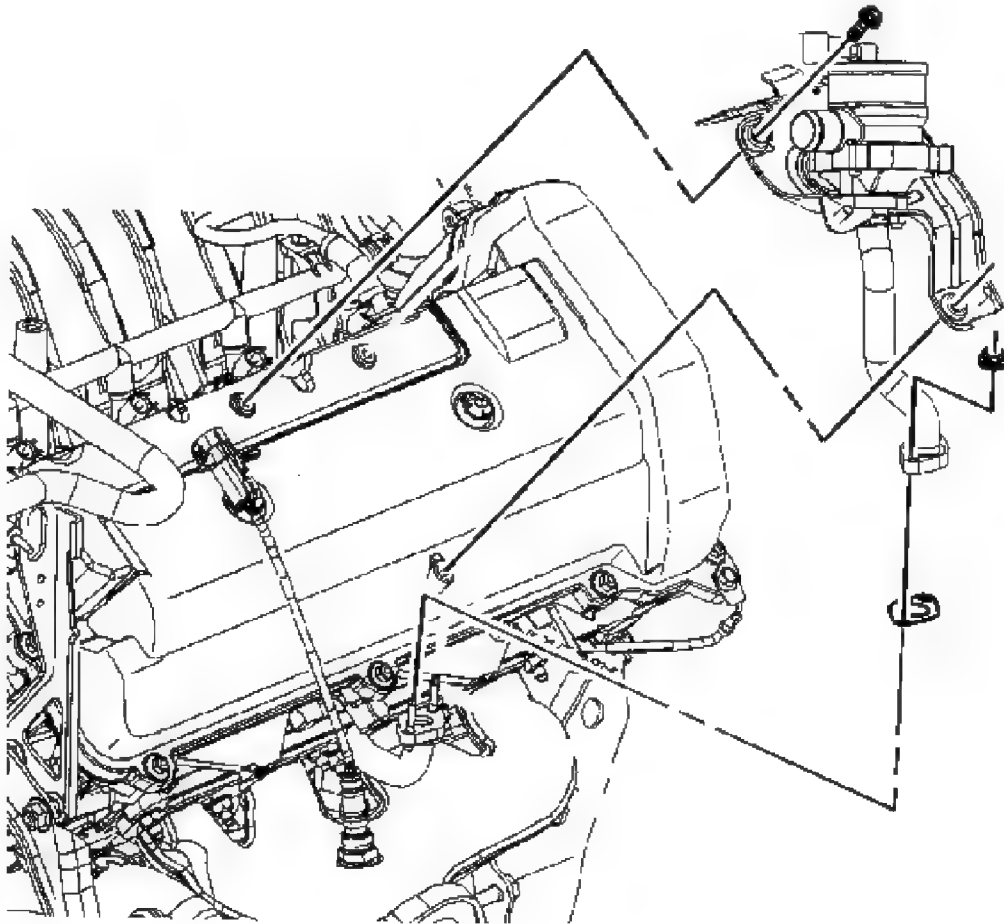


Fig. 139: Identifying Secondary Air Injection Valve Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the old secondary air injection (AIR) valve pipe gasket.

8. Install the NEW AIR valve pipe gasket.
9. Install the AIR valve.
10. Install the AIR valve bolts through the mounting bracket.

Tighten: Tighten the AIR valve bolts to 9 N.m (80 lb in).

11. Install the AIR valve pipe nuts to the exhaust manifold.

Tighten: Tighten the AIR valve pipe nuts to 9 N.m (80 lb in).

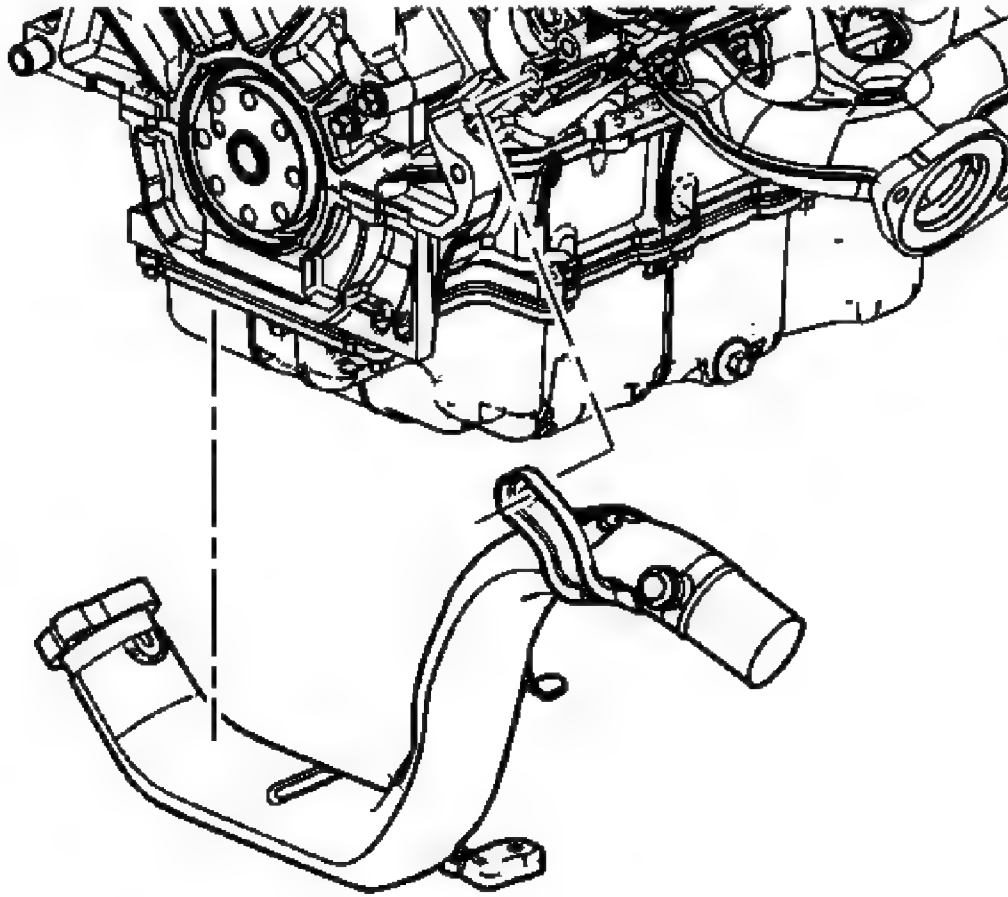


Fig. 140: Identifying Exhaust Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

12. Install the exhaust intermediate pipe.

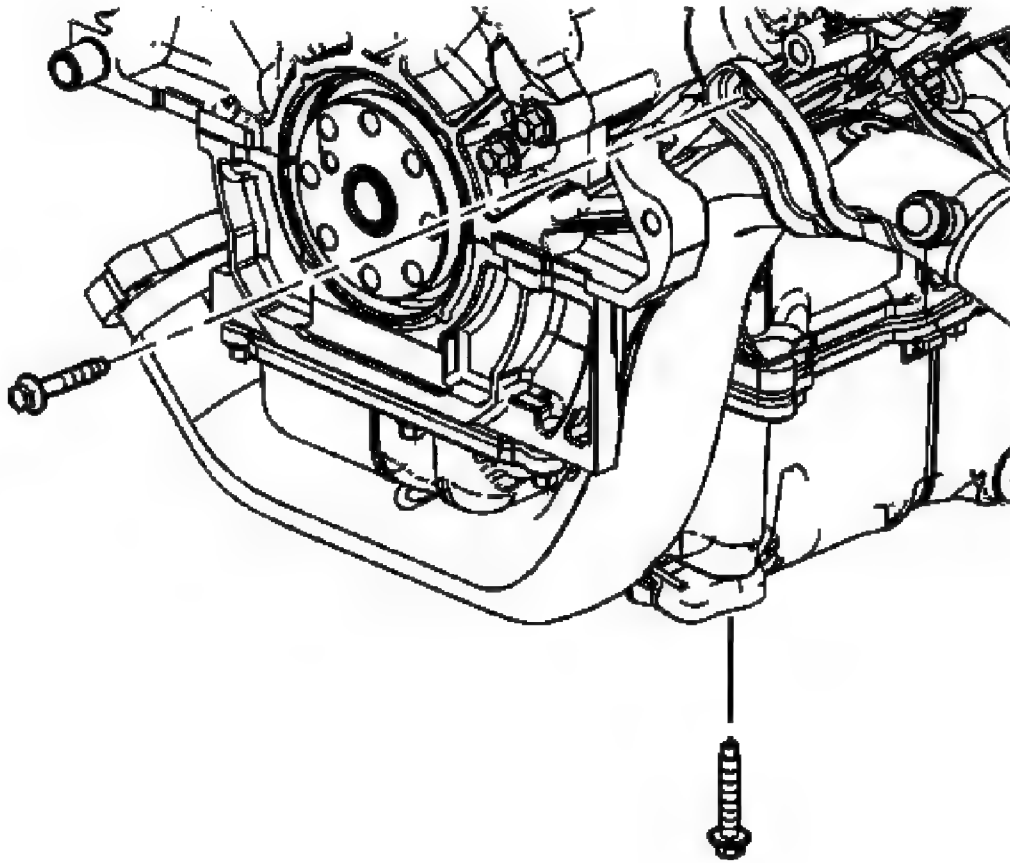


Fig. 141: View Of Exhaust Intermediate Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the exhaust intermediate pipe bolts.

Tighten: Tighten the exhaust intermediate pipe bolts to 30 N.m (22 lb ft).

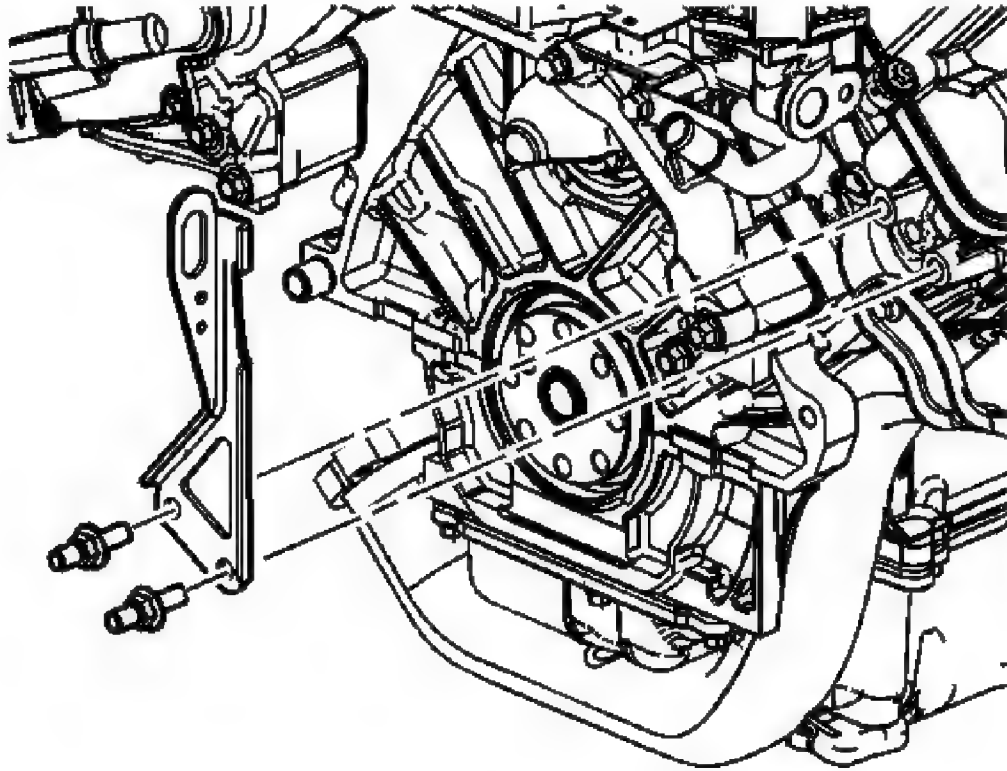


Fig. 142: Identifying Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS CORP.

14. Install the engine rear lift bracket.
15. Install the engine rear lift bracket bolts.

Tighten: Tighten the engine rear lift bracket bolts to 30 N.m (22 lb ft).

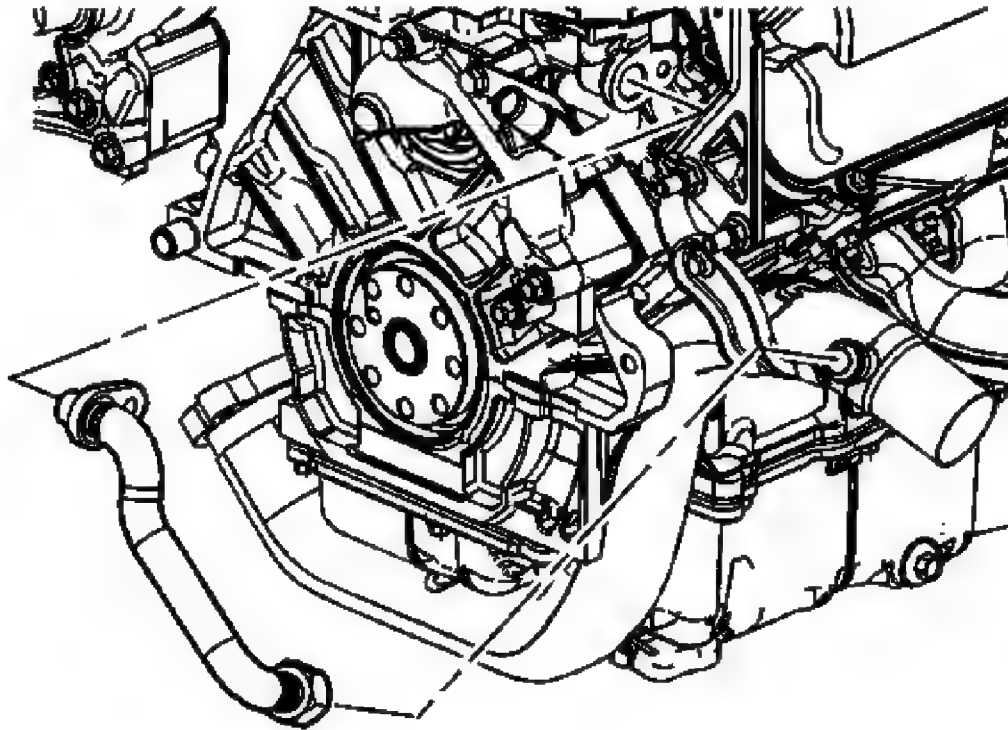


Fig. 143: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The exhaust gas recirculation (EGR) valve inlet pipe incorporates a crush seal connection at the water crossover. The EGR valve inlet pipe must be replaced if disconnected from the water crossover.

16. Install the NEW EGR valve inlet pipe into the water crossover port.

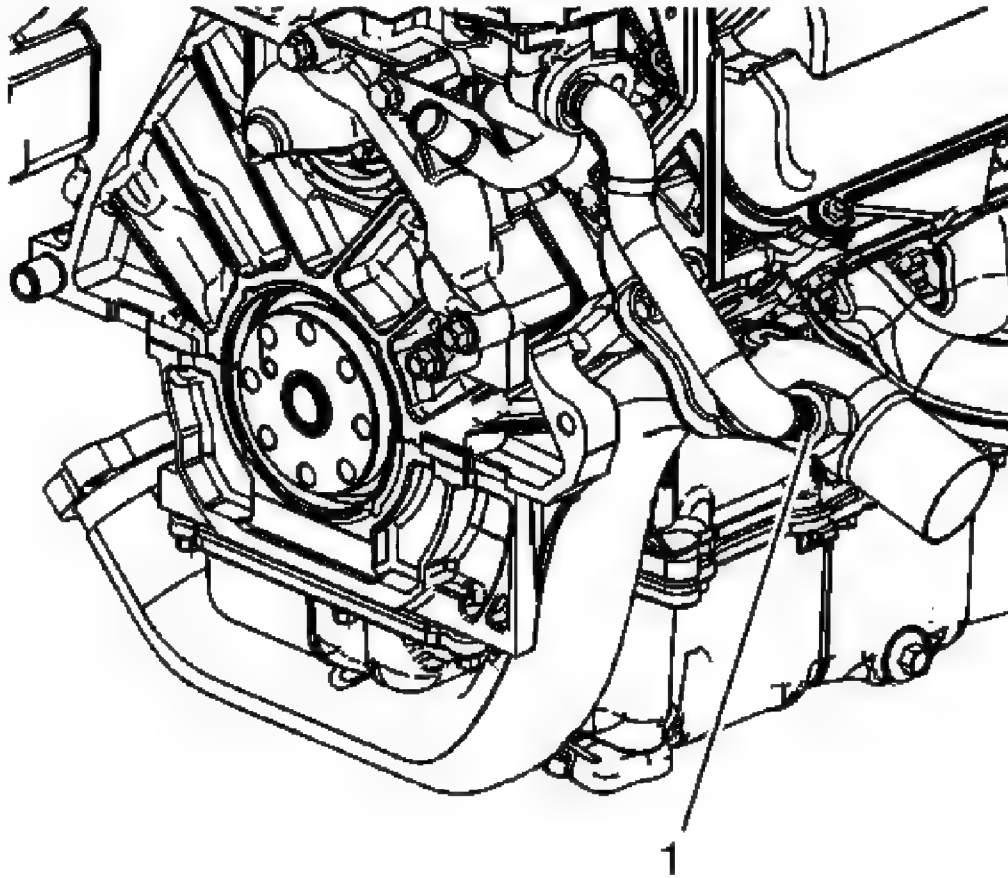


Fig. 144: Identifying EGR Valve Inlet Pipe Nut
Courtesy of GENERAL MOTORS CORP.

17. Loosely thread the EGR valve inlet pipe nut (1) onto the fitting on the exhaust intermediate pipe.

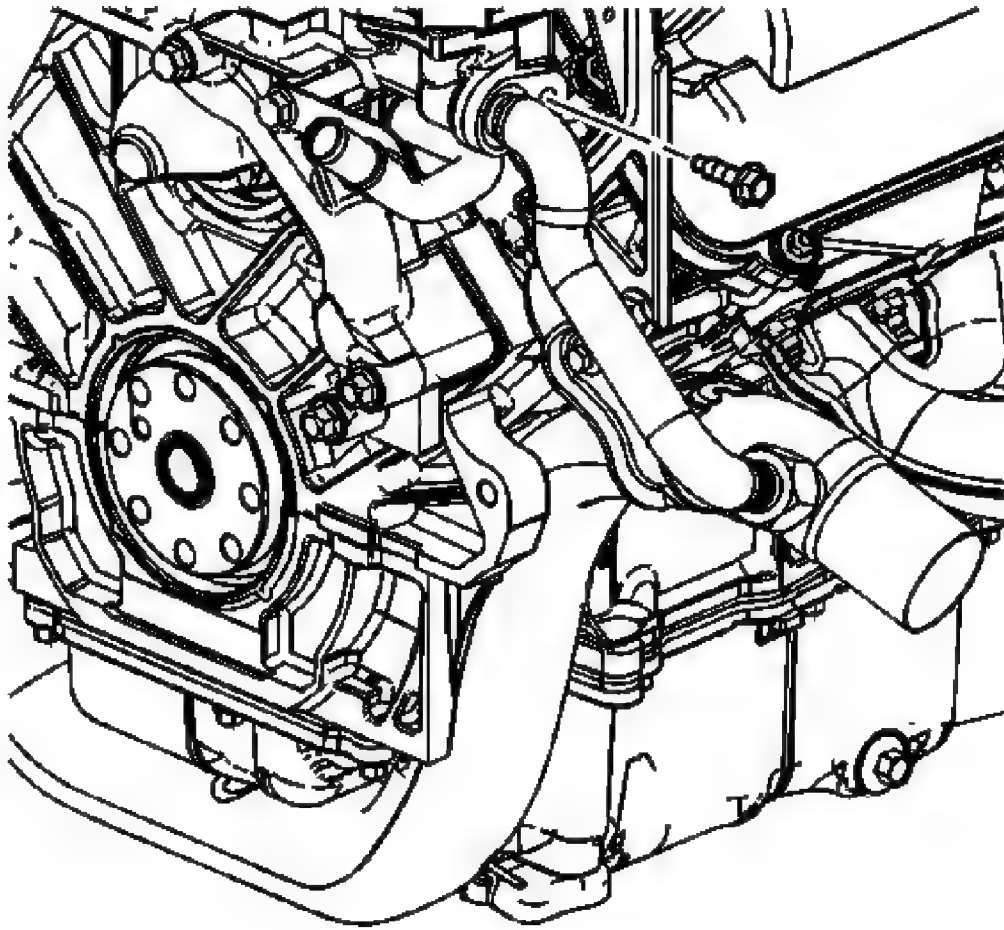


Fig. 145: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

18. Loosely thread the EGR valve inlet pipe bolt into the water crossover.
19. Tighten the EGR valve inlet pipe nut.

Tighten: Tighten the EGR valve inlet pipe nut to 60 N.m (44 lb ft).

20. Tighten the EGR valve inlet pipe bolt.

Tighten: Tighten the EGR valve inlet pipe bolt to 28 N.m (21 lb ft).

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE (W/O RPO NC1 OR NF7)

INSTALLATION PROCEDURE

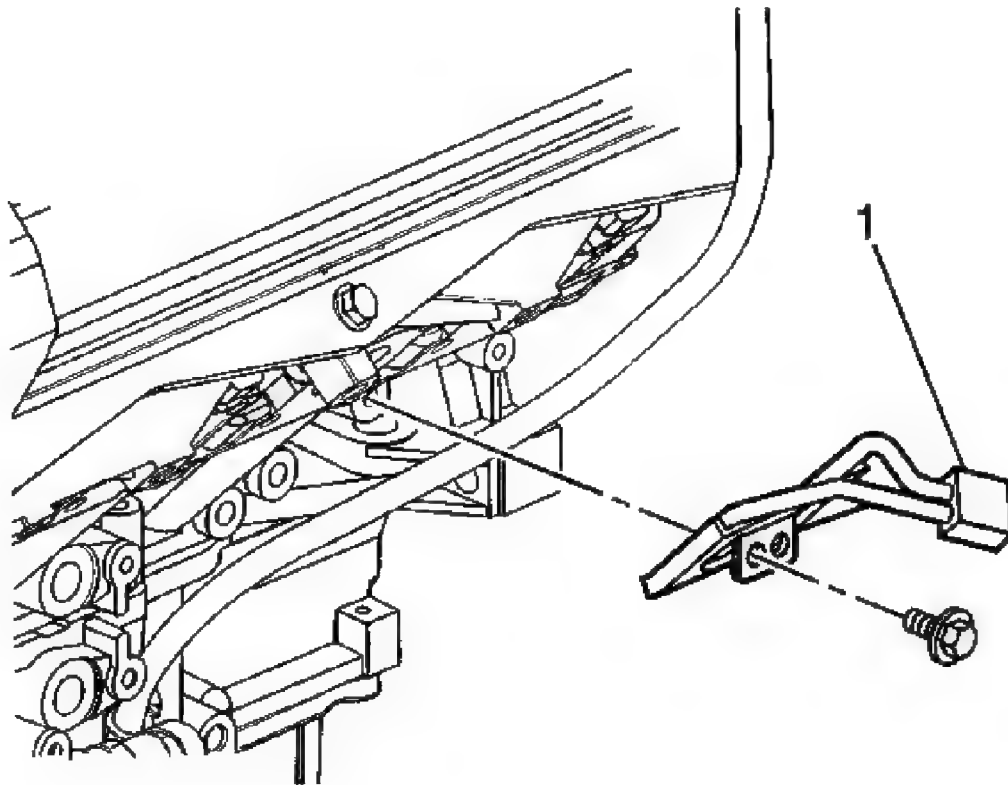


Fig. 146: Locating Left Side Coolant Heater
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

1. If the engine is equipped with coolant heaters, install the left side (1) heater as follows:
 1. Place the coolant heater (1) in position on the cylinder block.
 2. Install the coolant heater bolt.

Tighten: Tighten the coolant heater bolt to 10 N.m (89 lb in).

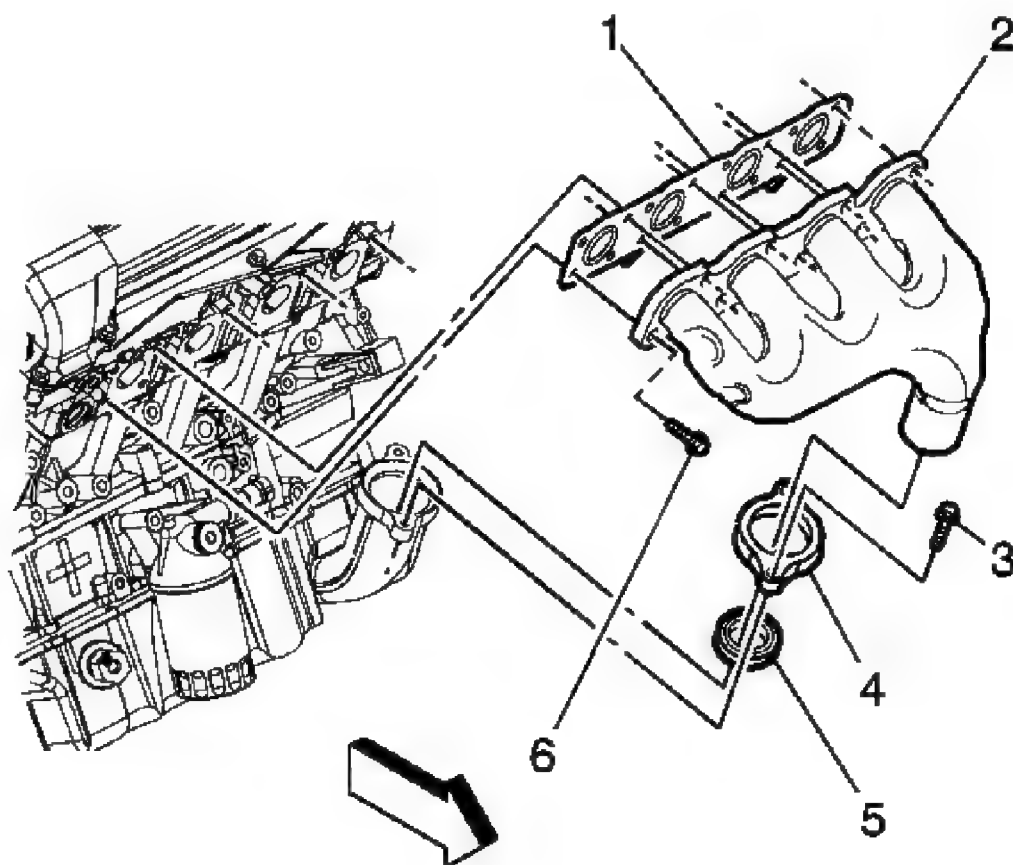


Fig. 147: Identifying Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

2. With the manifold still on the bench, position a new manifold gasket (1) in place on the manifold sealing surface.
3. Install 2 outer manifold bolts (6) in the manifold to retain the gasket.
4. Install a new manifold to intermediate pipe flange gasket (5).
5. Using 2 hands, place the manifold (2) in the intermediate pipe and onto the cylinder head.
6. Install new manifold flange bolts (3) for maximum joint integrity. Hand tighten. Do not torque the flange bolts to specification until the engine is mounted in the vehicle.
7. Hand tighten the 2 outer manifold bolts.
8. Install the remaining manifold bolts.

Tighten: Tighten the exhaust manifold bolts (6) to 25 N.m (18 lb ft).

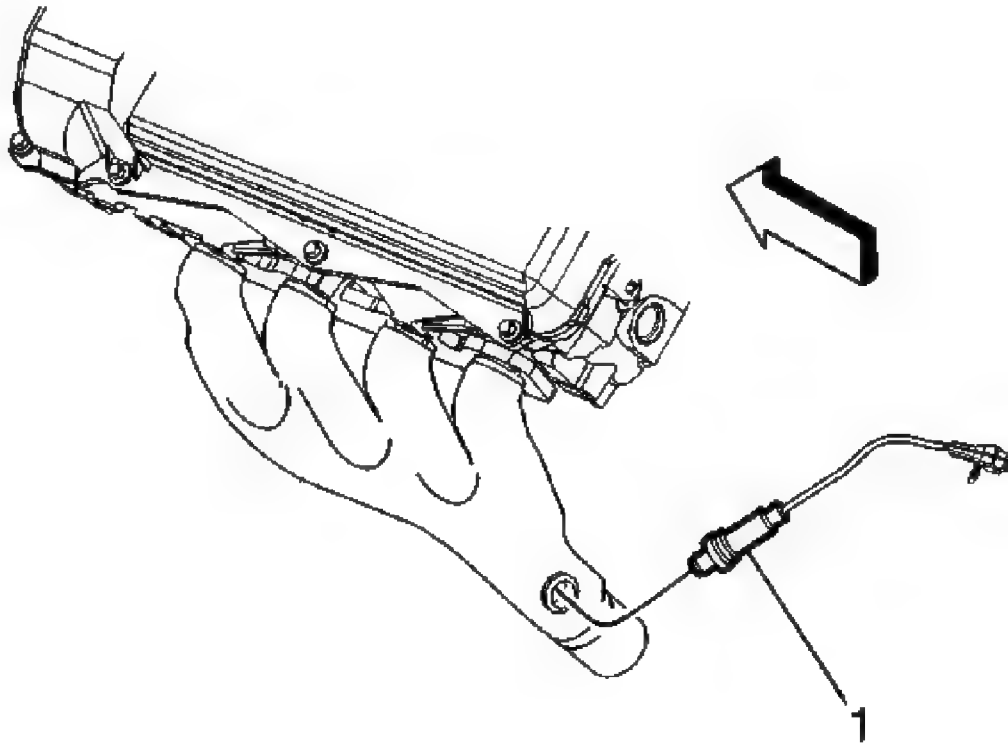


Fig. 148: Identifying Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

9. Coat the oxygen sensor threads with high temperature anti-seize, GM P/N 12377953 or equivalent.
10. Install the oxygen sensor (1).

Tighten: Tighten the oxygen sensor to 40 N.m (30 lb ft).

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE (WITH RPO NC1 OR NF7)

INSTALLATION PROCEDURE

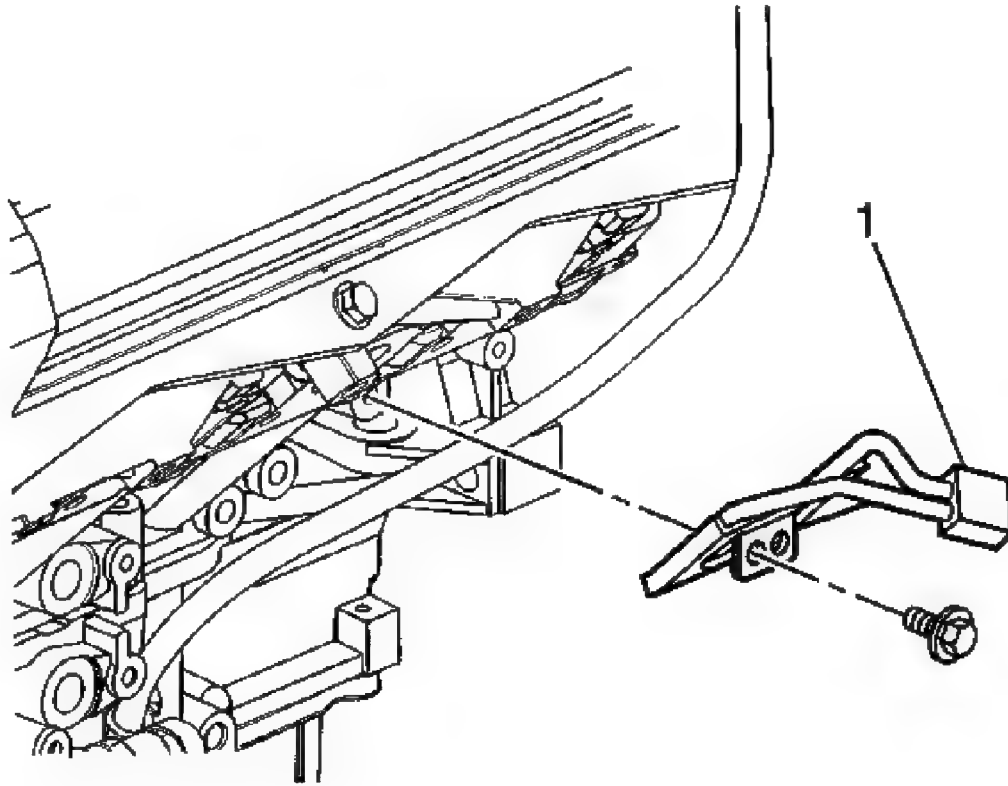


Fig. 149: Locating Left Side Coolant Heater
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. If the engine is equipped with coolant heaters, install the left side (1) heater as follows:
 1. Place the coolant heater (1) in position on the cylinder block.
 2. Install the coolant heater bolt.

Tighten: Tighten the coolant heater bolt to 10 N.m (89 lb in).

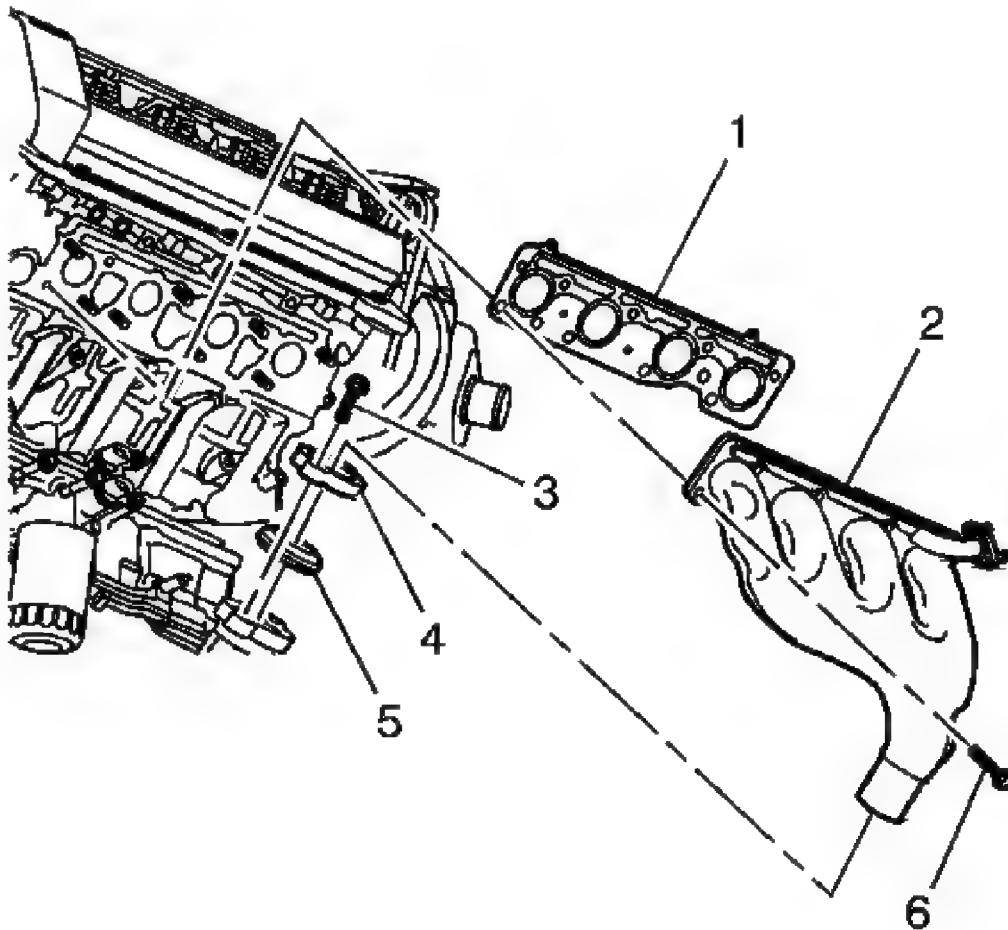


Fig. 150: View Of Left Exhaust Manifold & Components (With RPO NC1 or NF7)

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the exhaust manifold gasket.

2. With the manifold still on the bench, position a new manifold gasket (1) in place on the manifold sealing surface.
3. Install 2 outer manifold bolts (6) in the manifold to retain the gasket.
4. Install a new manifold to intermediate pipe flange gasket (5).
5. Using 2 hands, place the manifold (2) in the intermediate pipe and onto the cylinder head.
6. Install new manifold flange bolts (3) for maximum joint integrity. Hand tighten. Do not torque the flange bolts to specification until the engine is mounted in the vehicle.

7. Hand tighten the 2 outer manifold bolts.
8. Install the remaining manifold bolts.

Tighten: Tighten the exhaust manifold bolts (6) to 25 N.m (18 lb ft).

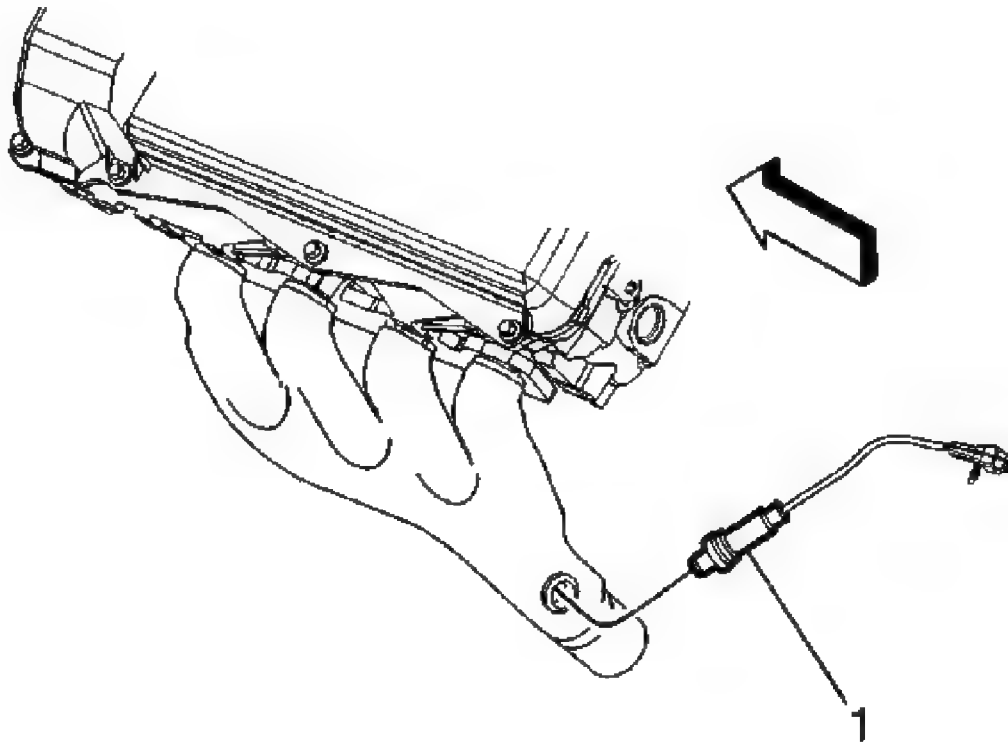


Fig. 151: Identifying Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

9. Coat the oxygen sensor threads with high temperature anti-seize, GM P/N 12377953 or equivalent.
10. Install the oxygen sensor (1).

Tighten: Tighten the oxygen sensor to 40 N.m (30 lb ft).

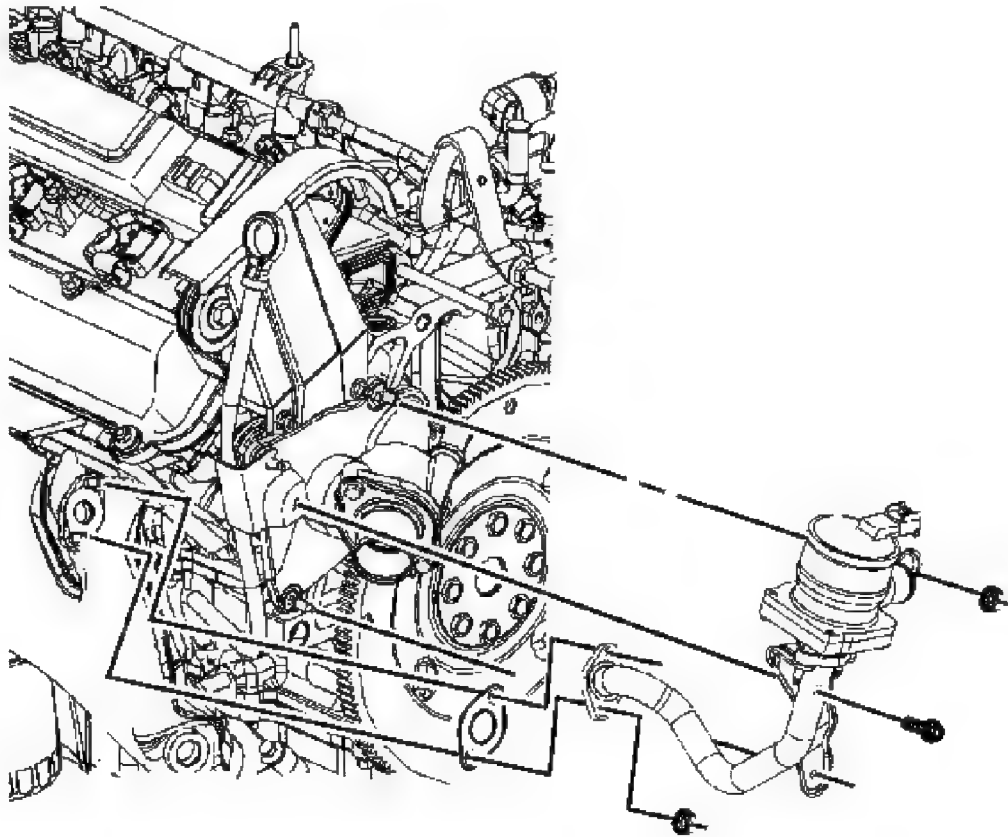


Fig. 152: View of Secondary Air Injection Valve
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the old secondary air injection (AIR) valve pipe gasket.

11. Install the NEW AIR valve pipe gasket.
12. Install the AIR valve.
13. Install the AIR valve nuts to the mounting bracket.

Tighten: Tighten the AIR valve nuts to 9 N.m (80 lb in).

14. Install the AIR valve bolt through the mounting bracket.

Tighten: Tighten the AIR valve bolt to 9 N.m (80 lb in).

15. Install the AIR valve pipe nuts to the exhaust manifold.

Tighten: Tighten the AIR valve pipe nuts to 9 N.m (80 lb in).

OIL LEVEL INDICATOR AND TUBE INSTALLATION

INSTALLATION PROCEDURE

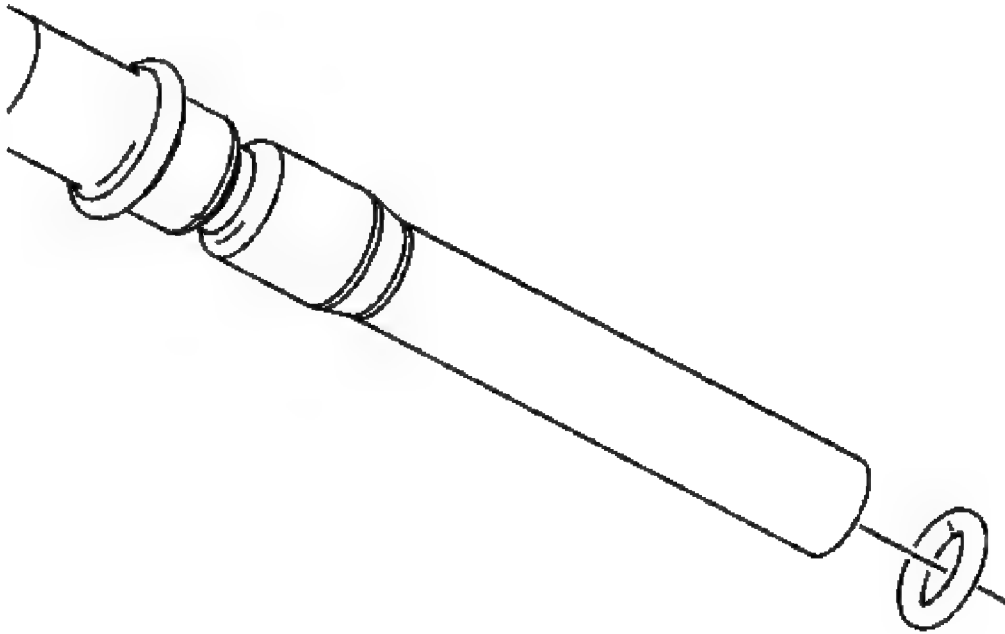


Fig. 153: Removing & Installing Oil Level Indicator Tube & O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW O-ring on the oil level indicator tube.

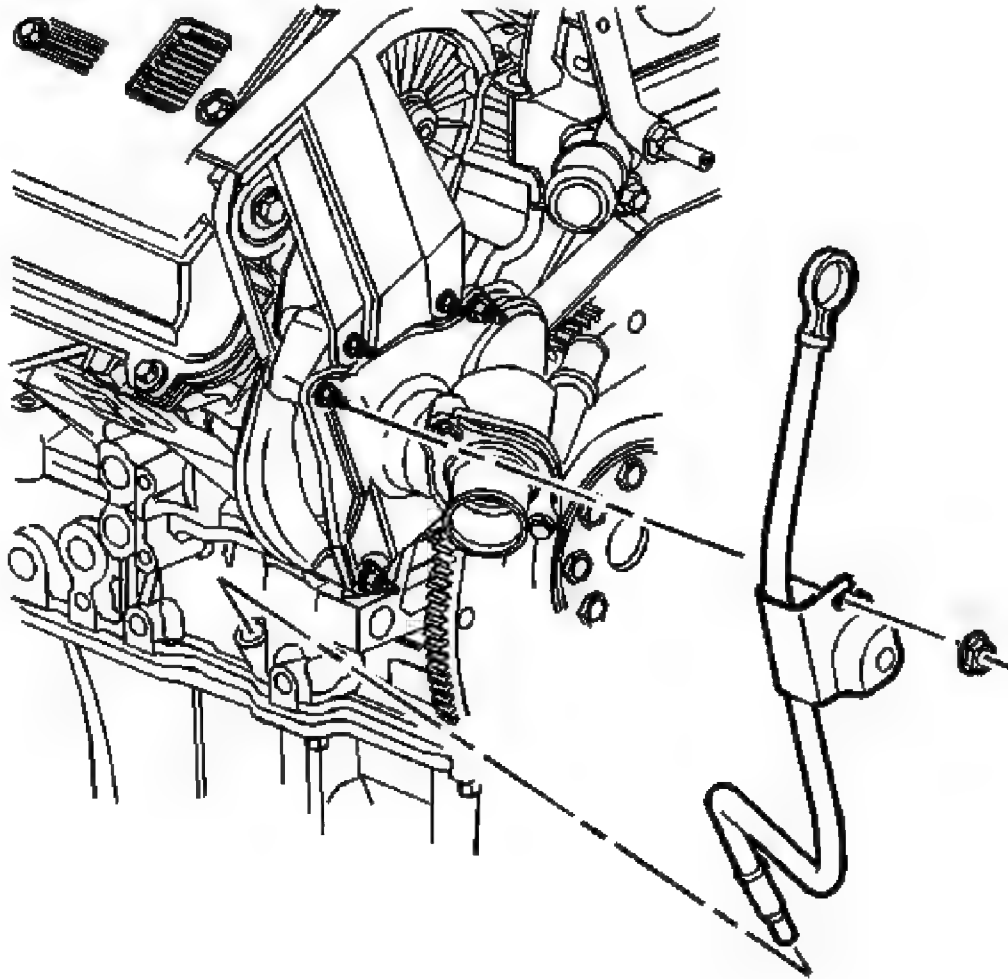


Fig. 154: View of Oil Lever Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

2. Install the oil level indicator tube.

NOTE: Refer to FASTENER NOTICE .

3. Install the oil level indicator tube nut.

Tighten: Tighten the oil level indicator tube nut to 10 N.m (89 lb in).

CRANKSHAFT REAR OIL SEAL INSTALLATION

TOOLS REQUIRED

- **EN-48072** Sealant Applicator. See **Special Tools** .
- **J 45930-A** Crankshaft Rear Oil Seal Installer. See **Special Tools** .

INSTALLATION PROCEDURE

IMPORTANT: The EN-48072 must be used to ensure even application of the sealant in the bore and to prevent blockage of the drain back hole. See **Special Tools** .

IMPORTANT: Ensure components that are being sealed with RTV sealant are assembled within 20 minutes. Components assembled after the RTV sealant has skinned-over, approximately 20 minutes, will not bond properly.

IMPORTANT: Although originally equipped with a lip-style crankshaft rear oil seal, engines built from March 1, 1996 and thru 1999 should use the cassette-style crankshaft rear oil seal.

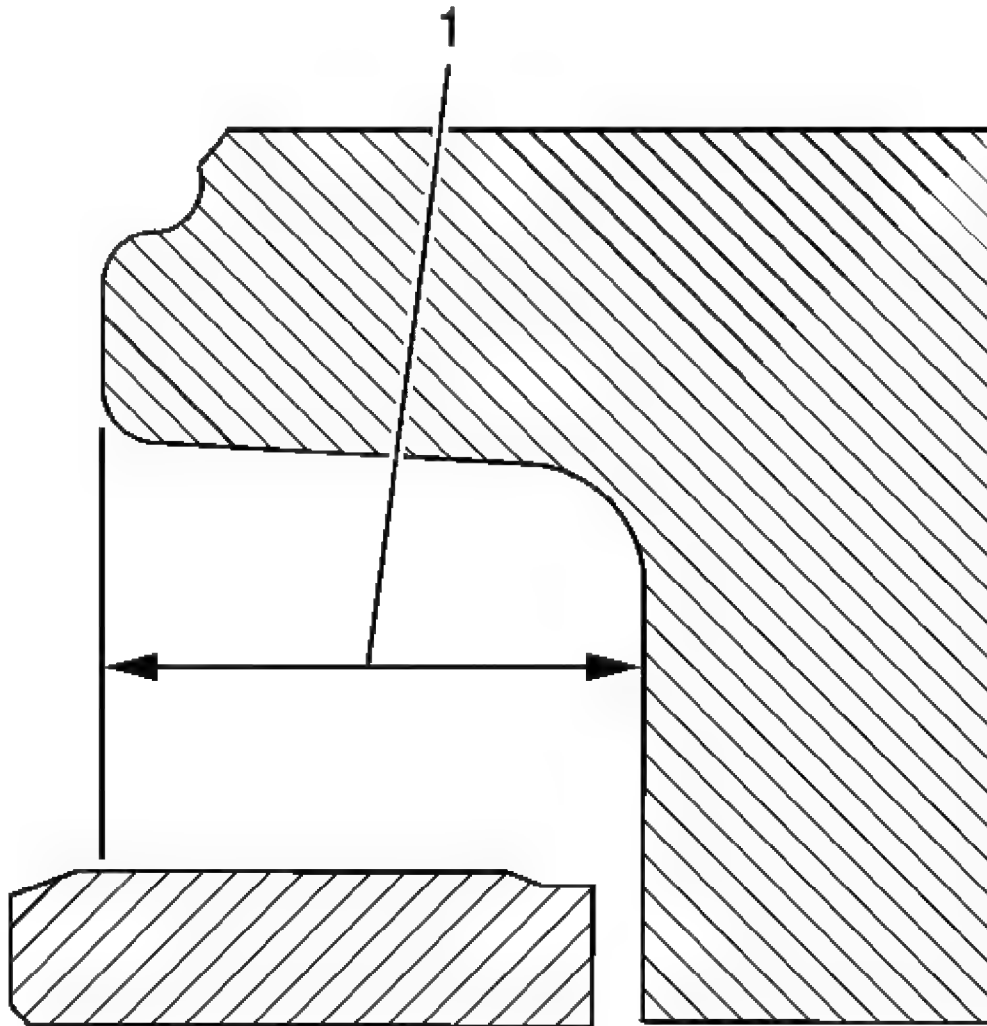


Fig. 155: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Ensure the engine block where the crankshaft rear oil seal is installed is a deep bore (1).
 - A deep bore of approximately 15 mm (0.5906 in) was used on engines from March 1, 1996 and later.
 - A shallow bore of approximately 8 mm (0.3150 in) was used on engines from 1993 thru February 29, 1996. This block would use a lip-style crankshaft rear oil seal and the **J 38817-A** for installation.

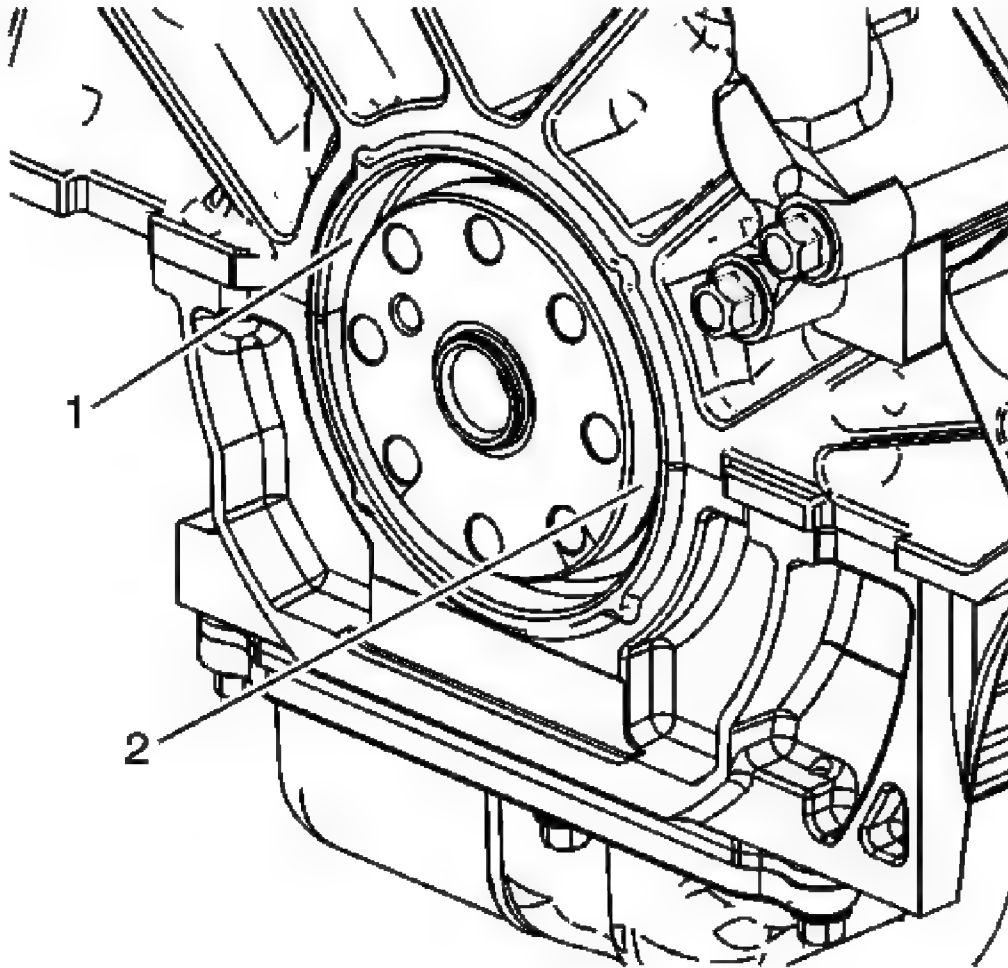


Fig. 156: Identifying Rear Crankshaft Seal Bore & Flange
Courtesy of GENERAL MOTORS CORP.

2. Inspect the engine block bore (1) and the crankshaft flange (2) for the damage. Repair or replace any damaged components.

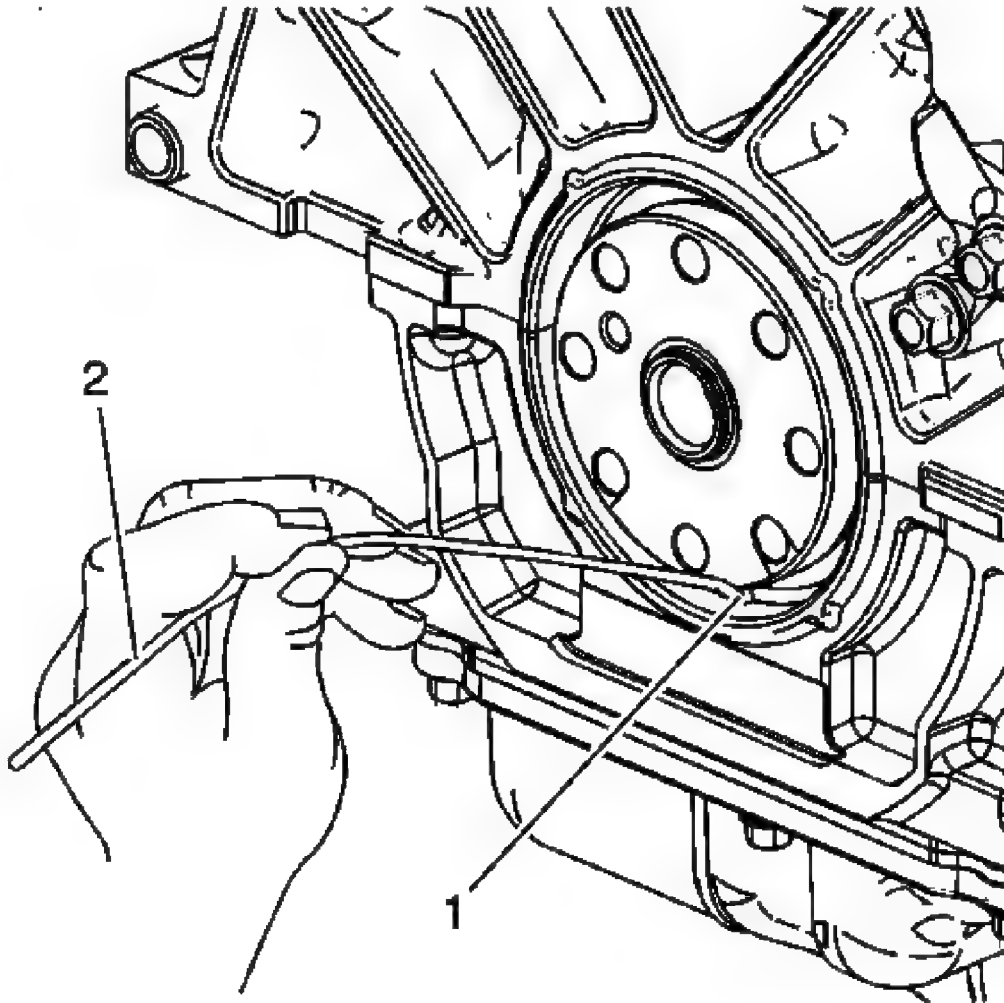


Fig. 157: Identifying Rear Oil Seat Drain
Courtesy of GENERAL MOTORS CORP.

3. Ensure the oil drain-back hole (1) is clear of debris using a wire or an unbound plastic tie wrap (2).

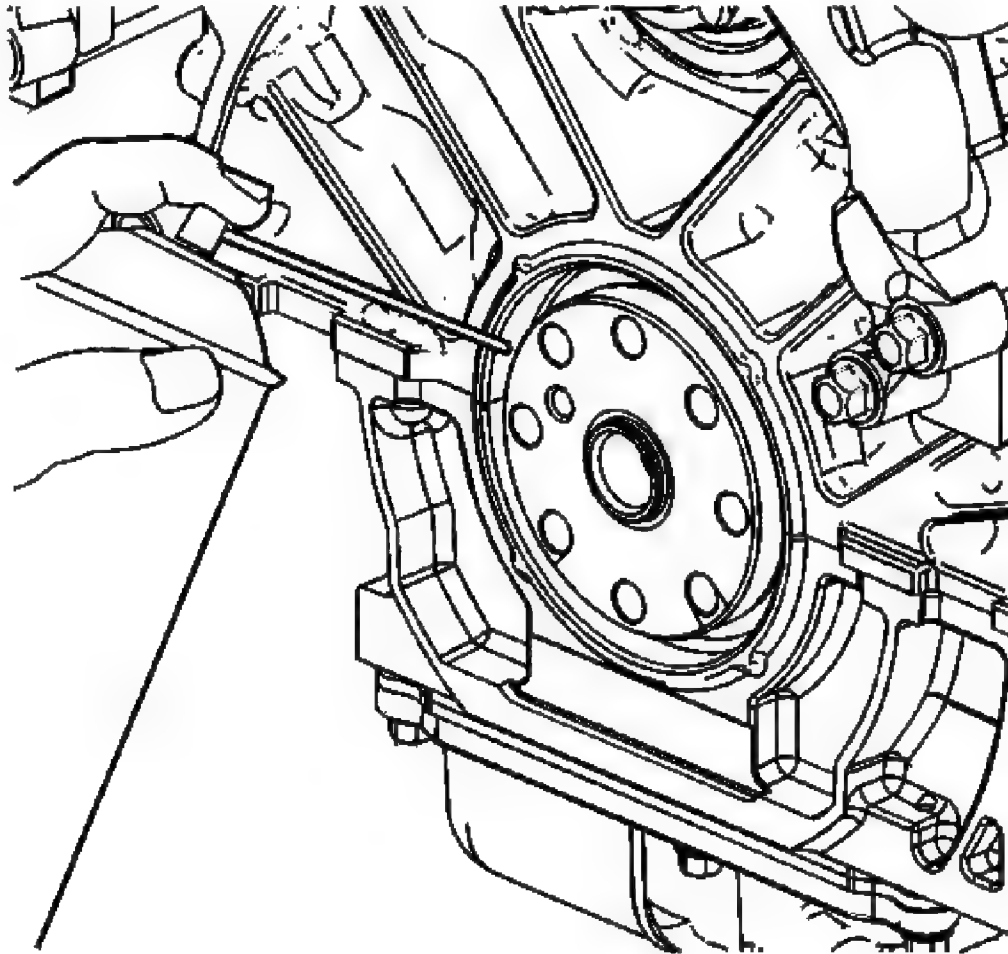


Fig. 158: Cleaning Rear Crankshaft Seal Bore
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: In order to ensure proper bonding of the sealant the bore must be clean and dry.

4. Clean the bore in the block with cleaner solvent GM P/N 12378392 or 12346139 (Canadian P/N 88901247).

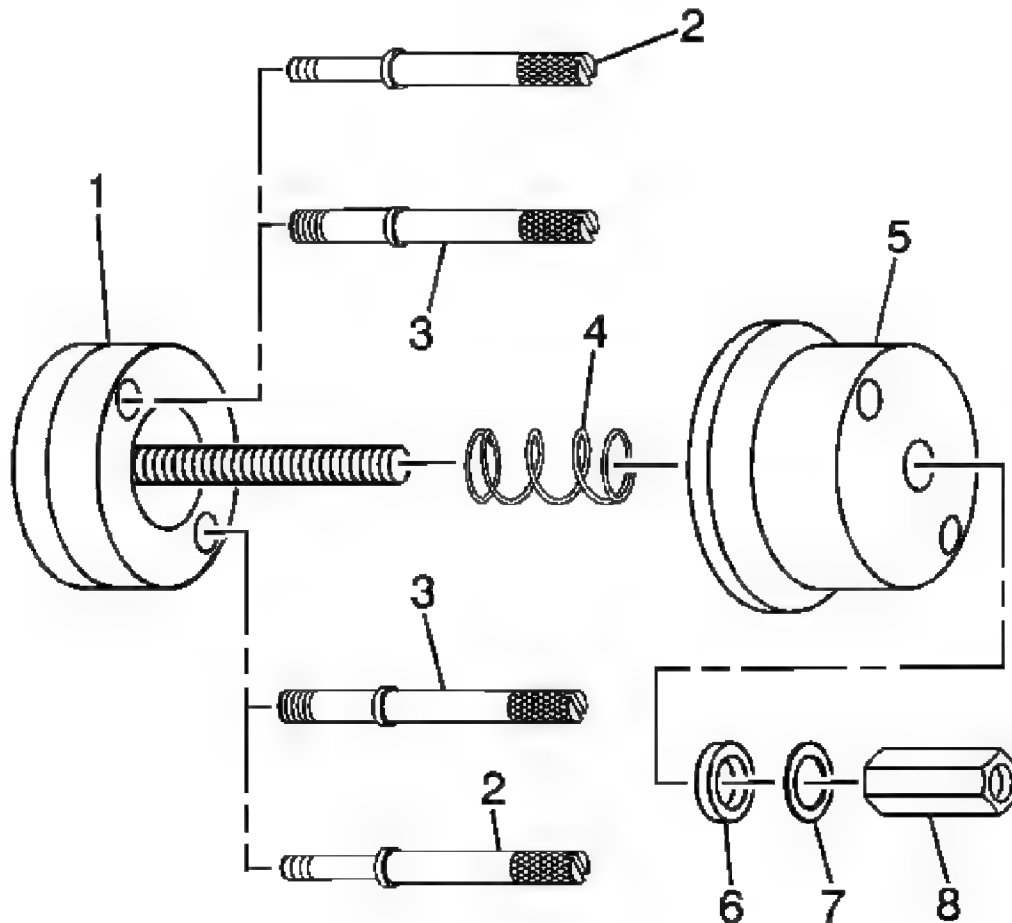


Fig. 159: View Of J 45930-A Tool Set
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

5. Remove the proper sized bolts from the **J 45930-A** . See **Special Tools** . Use the bolts (2) 8 mm or the bolts (3) 11 mm.

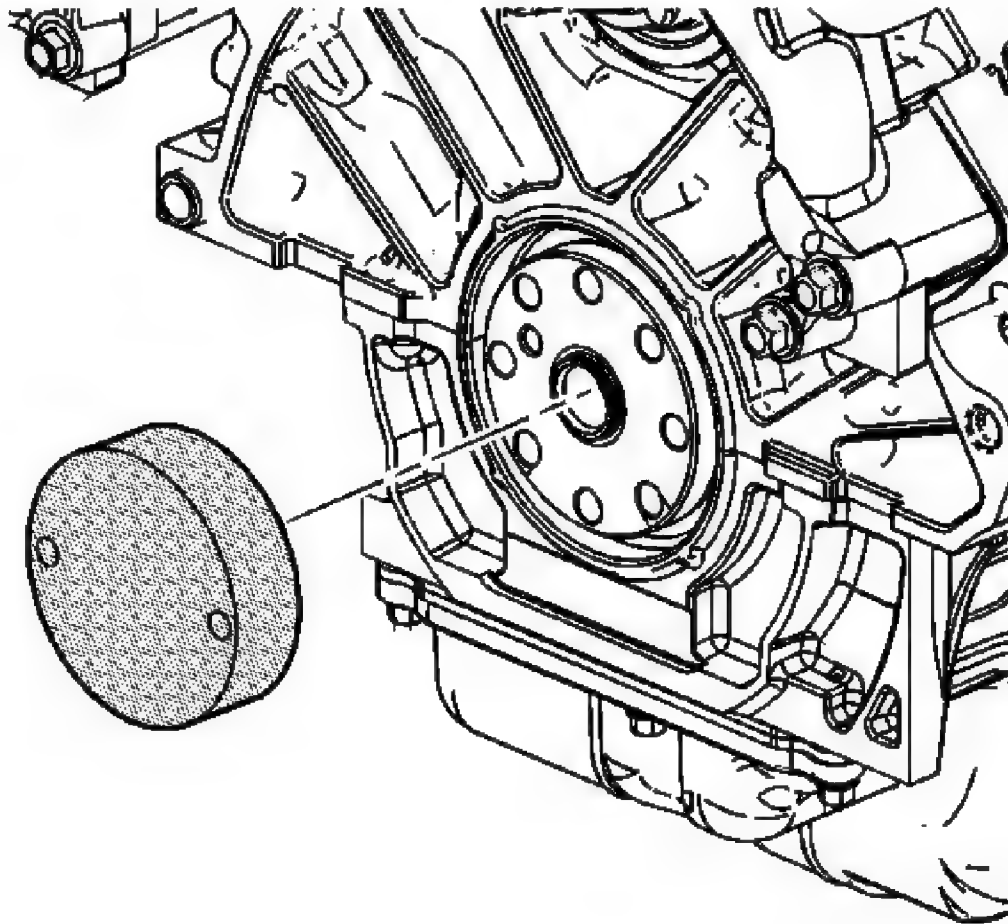


Fig. 160: Identifying Rear Seal Pilot Base
Courtesy of GENERAL MOTORS CORP.

6. Install the **EN-48072** pilot base onto the crankshaft. See **Special Tools** . The hub on the crankshaft will fit into the recess on the inboard side of the **EN-48072** pilot base. See **Special Tools** .

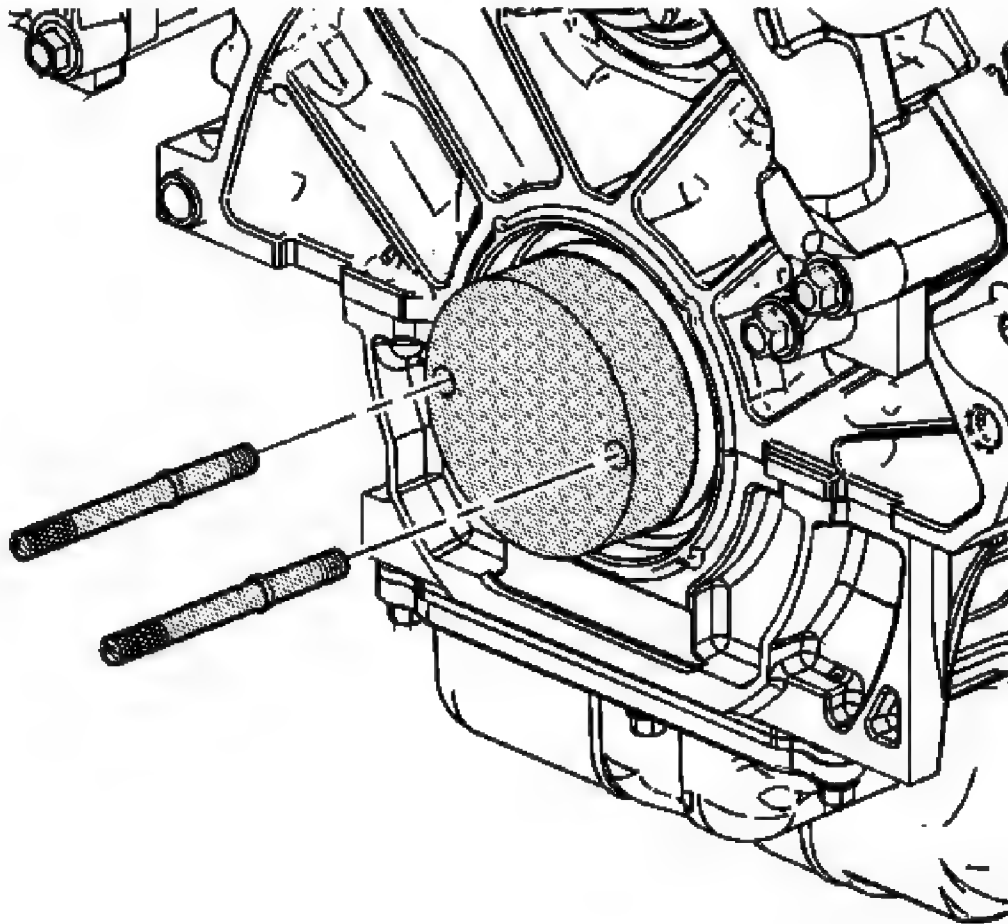


Fig. 161: View Of Pilot Base Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

7. Use the proper bolts from the **J 45930-A** to retain the **EN-48072** pilot base in place. See **Special Tools** .

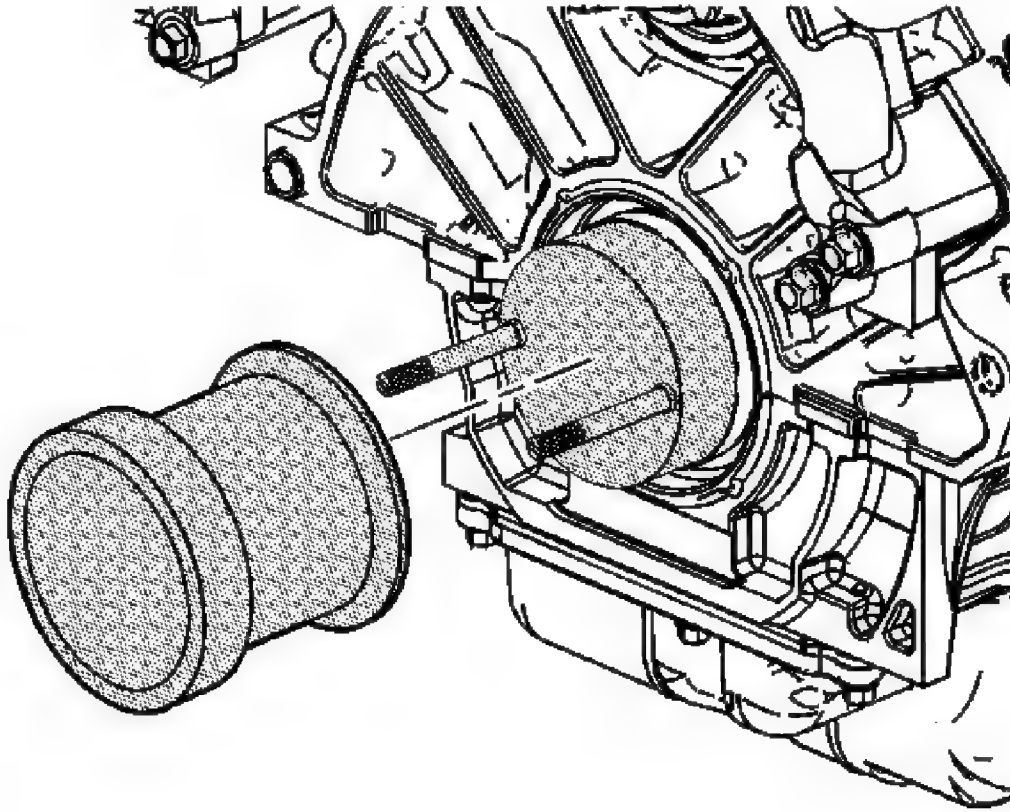


Fig. 162: View Of Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

8. Install the **EN-48072** applicator housing over the **EN-48072** pilot base. See **Special Tools** . Ensure the **EN-48072** applicator housing bottoms in the bore of the block. See **Special Tools** .

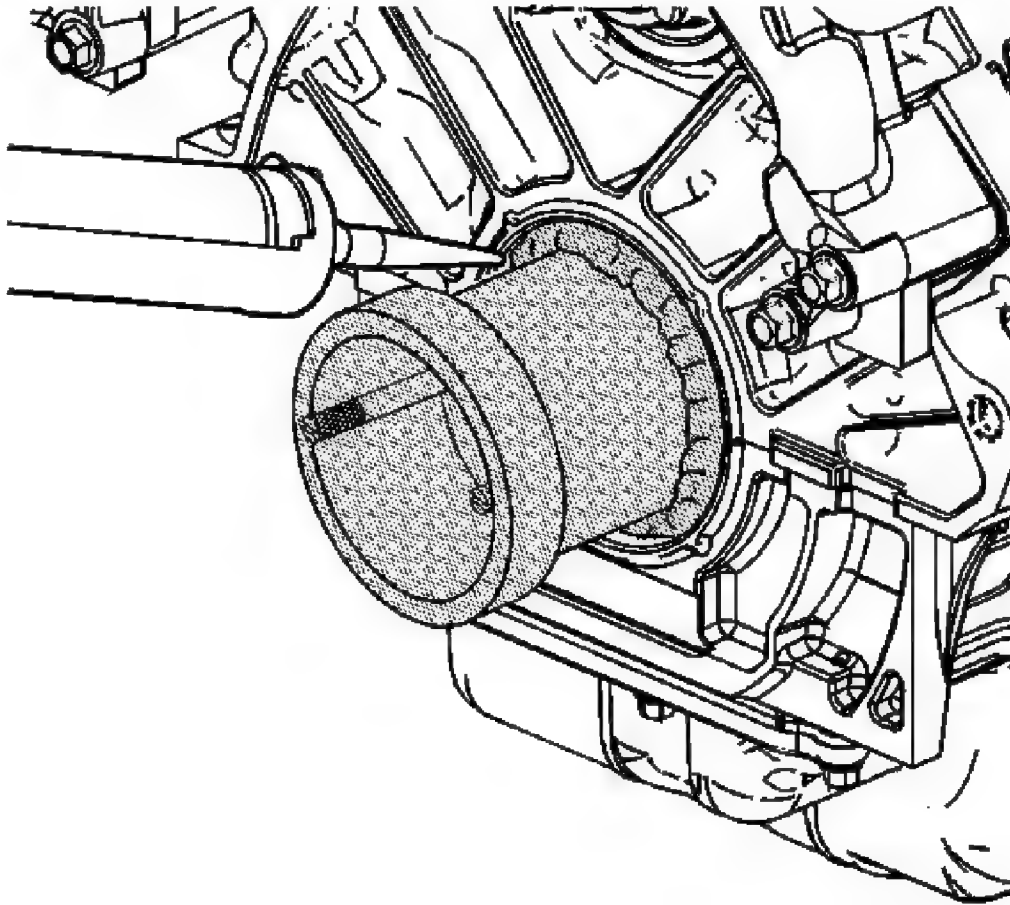


Fig. 163: Applying Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The sealant must not block the drain back hole. Blockage of the drain back hole can lead to oil leakage.

9. Apply the sealant GM P/N 12378521 (Canadian P/N 88901148) to the bore outer diameter in the block. Ensure the sealant does not block the drain hole.

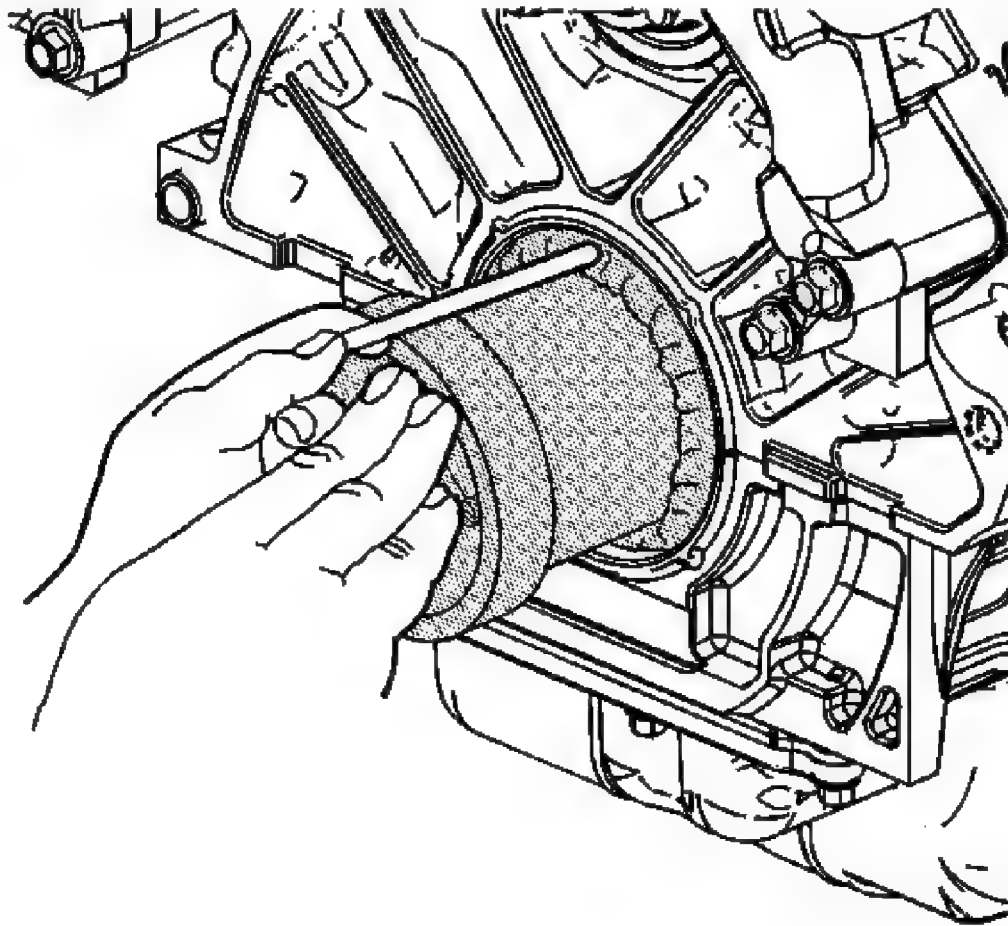


Fig. 164: Spreading Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Apply steady even pressure to the EN-48072 applicator housing. See Special Tools .

10. Using a suitable tool spread the sealant within the bore to ensure an even coating across the bore.

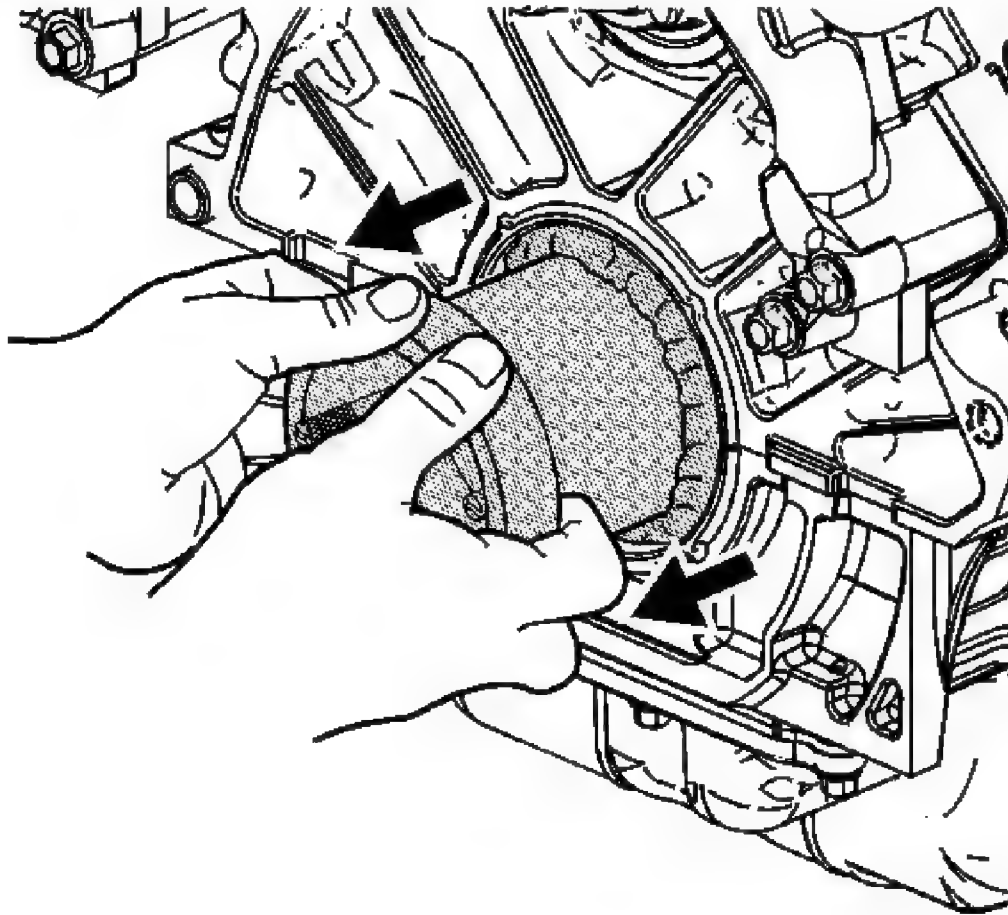


Fig. 165: Removing Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: In order to apply an even coat of the sealant do not twist or turn the EN-48072 applicator housing as it is pulled away from the bottom of the bore. See Special Tools .

11. Using both hands, slowly and evenly, pull the **EN-48072** applicator housing out of the bore and remove it from the **EN-48072** pilot base. See Special Tools .

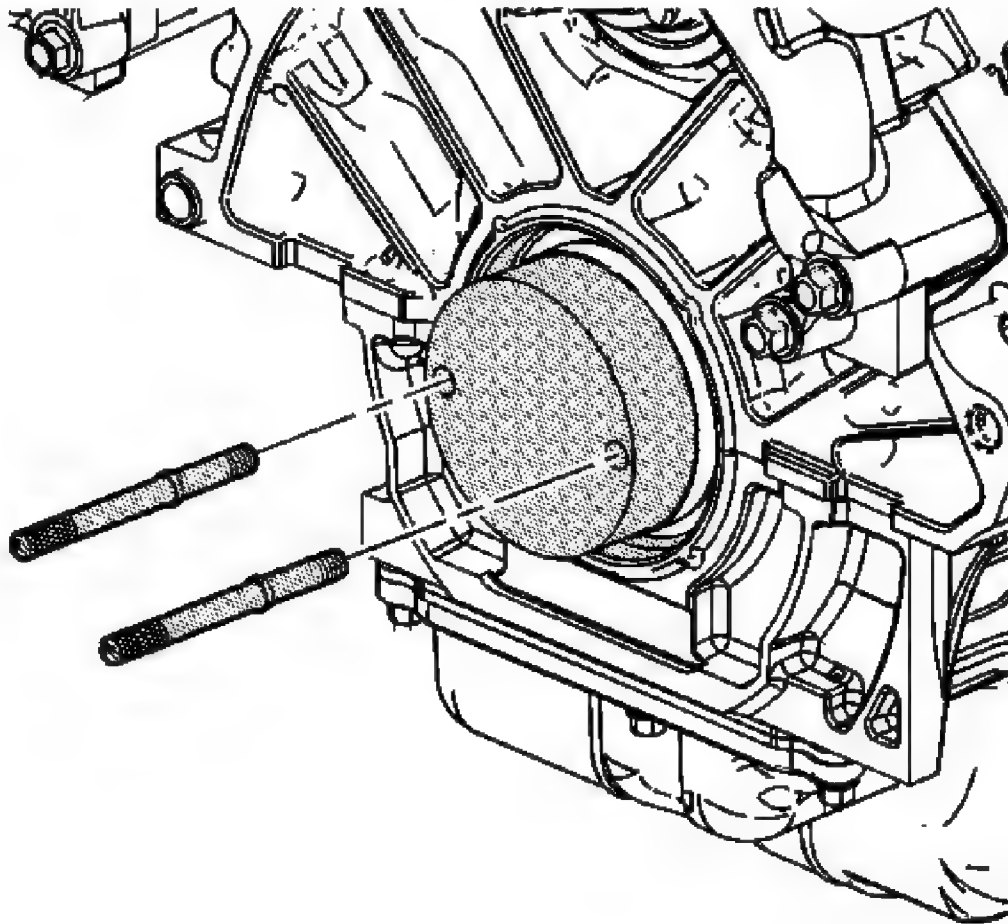


Fig. 166: Identifying Pilot Base Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the **J 45930-A** bolts from the **EN-48072** pilot base. See **Special Tools** .

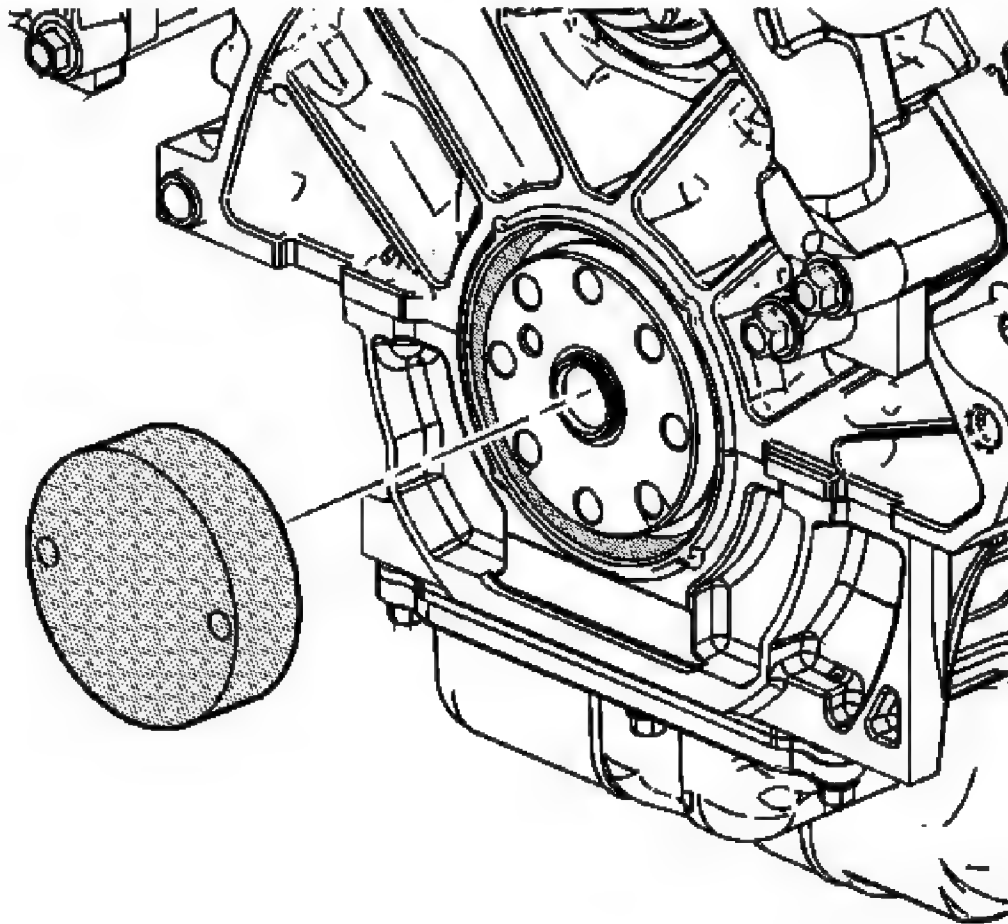


Fig. 167: View Of Rear Seal Pilot Base
Courtesy of GENERAL MOTORS CORP.

13. Remove the **EN-48072** pilot base. See **Special Tools** .

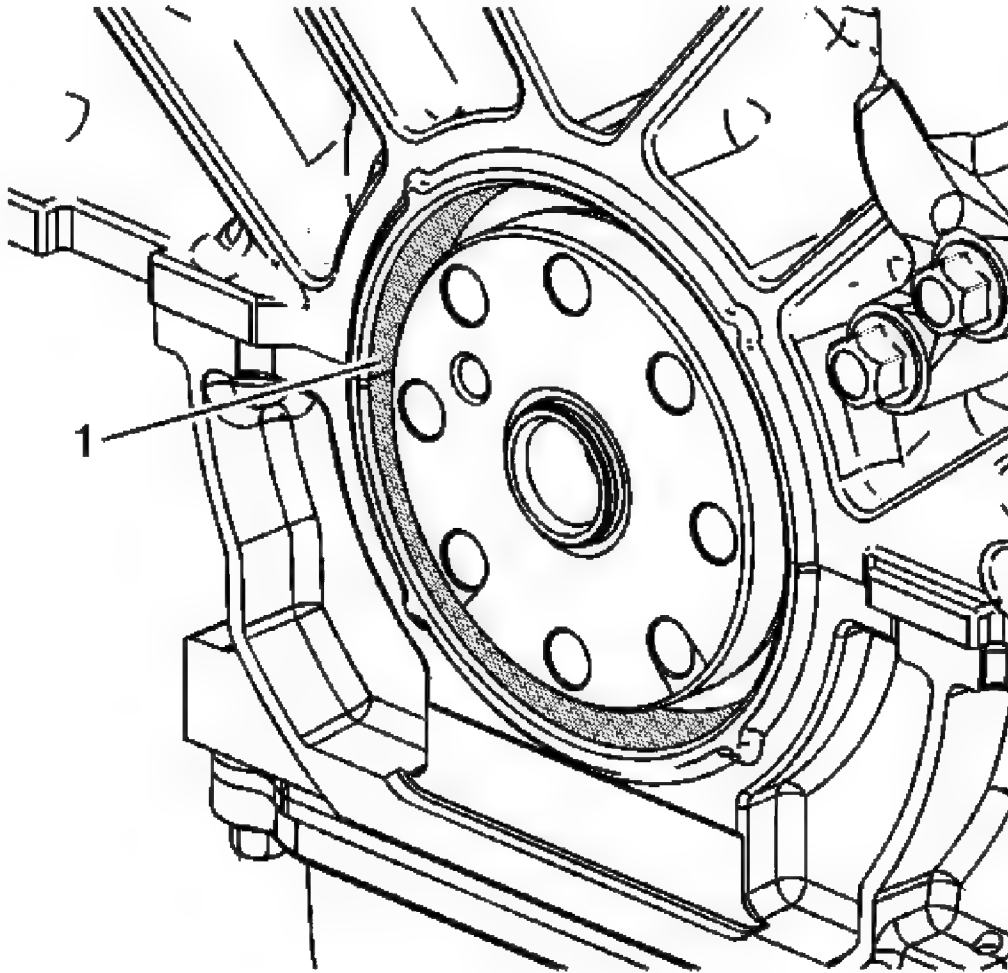


Fig. 168: Spreading Sealant Across Bore Of Block
Courtesy of GENERAL MOTORS CORP.

14. Ensure that the sealant (1) is evenly spread across the bore of the block.

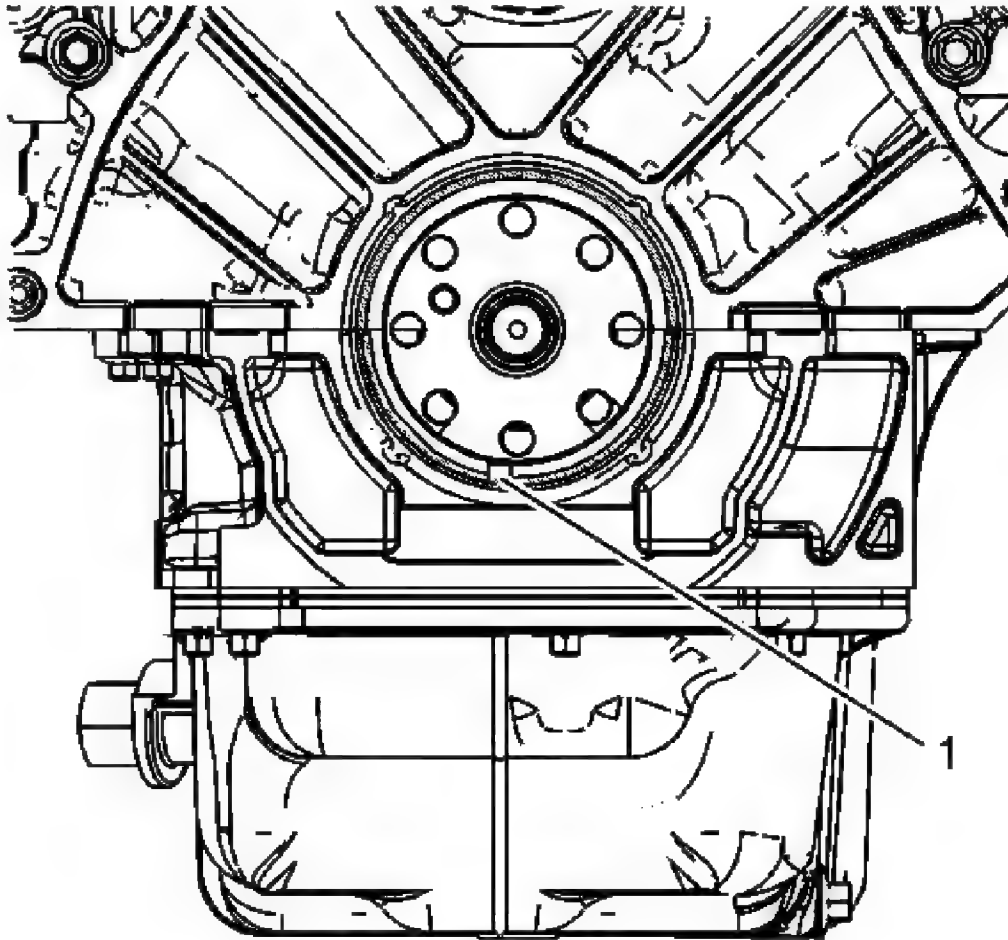


Fig. 169: Checking Seal Bore Drain Back Hole
Courtesy of GENERAL MOTORS CORP.

15. Ensure the drain back hole (1) is clear of the sealant.

NOTE: The cassette seal is installed onto the crankshaft with a press fit that requires over 135 Nm (100 lb ft) of force to remove or install. This high force requires the use of special tools to remove and install the seal. Use of any other tools during removal or installation can lead to damage to the seal or other components. An improperly installed or damaged seal can leak oil and can lead to engine damage. Use of the J 38817-A to install the cassette seal can damage the tool and cause improper seal installation and/or seal damage.

IMPORTANT: Beginning with the model year 2006 the flywheel/flexplate crankshaft bolt hole thread was changed from 8 x 1.25 mm to 11 x 1.5 mm. The J 45930-A will service the cassette seals installed on engines from March 1, 1996 to 2006. See Special Tools . If a J 45930 is to be used on a 2006 or later engine the update kit, J 45930-10, must be used to convert the J 45930 to a J 45930-A . See Special Tools .

IMPORTANT: Crankshaft rear oil seal and engine flywheel installation requires adequate space for installation. If the engine stand does not allow suitable space to use the J 45930-A install the crankshaft rear oil seal and engine flywheel with the engine properly supported on the floor or on a bench. See Special Tools .

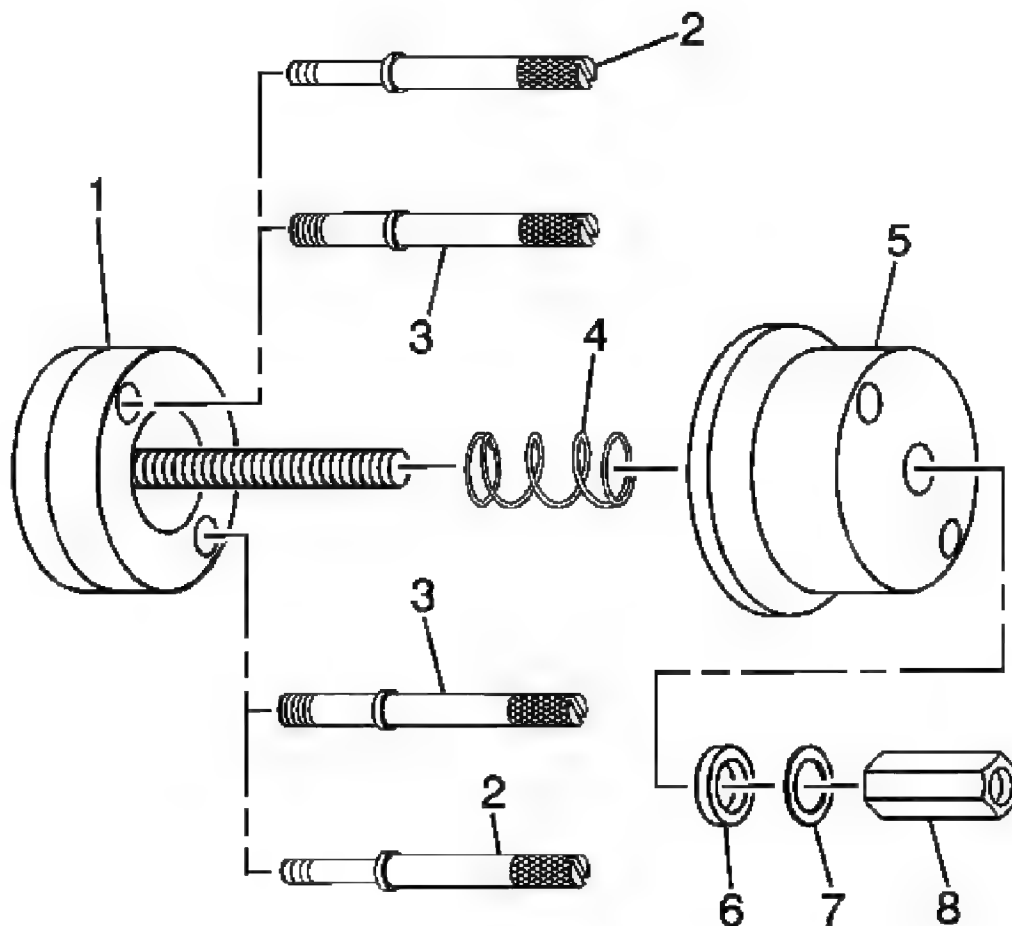


Fig. 170: View Of J 45930-A Tool Set
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

16. Ensure the proper size of bolt (2) 8 mm or (3) 11 mm is being installed in the **J 45930-A** . See **Special Tools** .

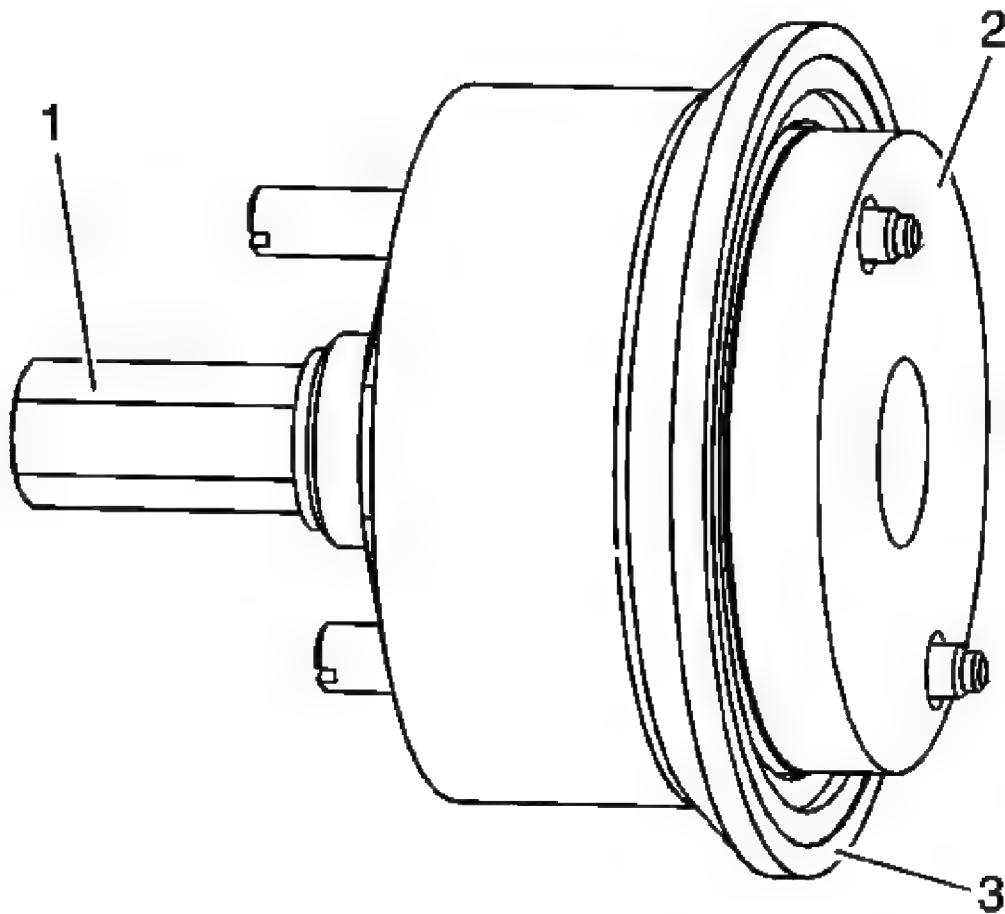


Fig. 171: View Of J 45930-A Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS CORP.

17. Turn the center nut (1) of the **J 45930-A** until the center hub (2) protrudes approximately

15 mm (0. See **Special Tools** .591 in) beyond the outer plate (3).

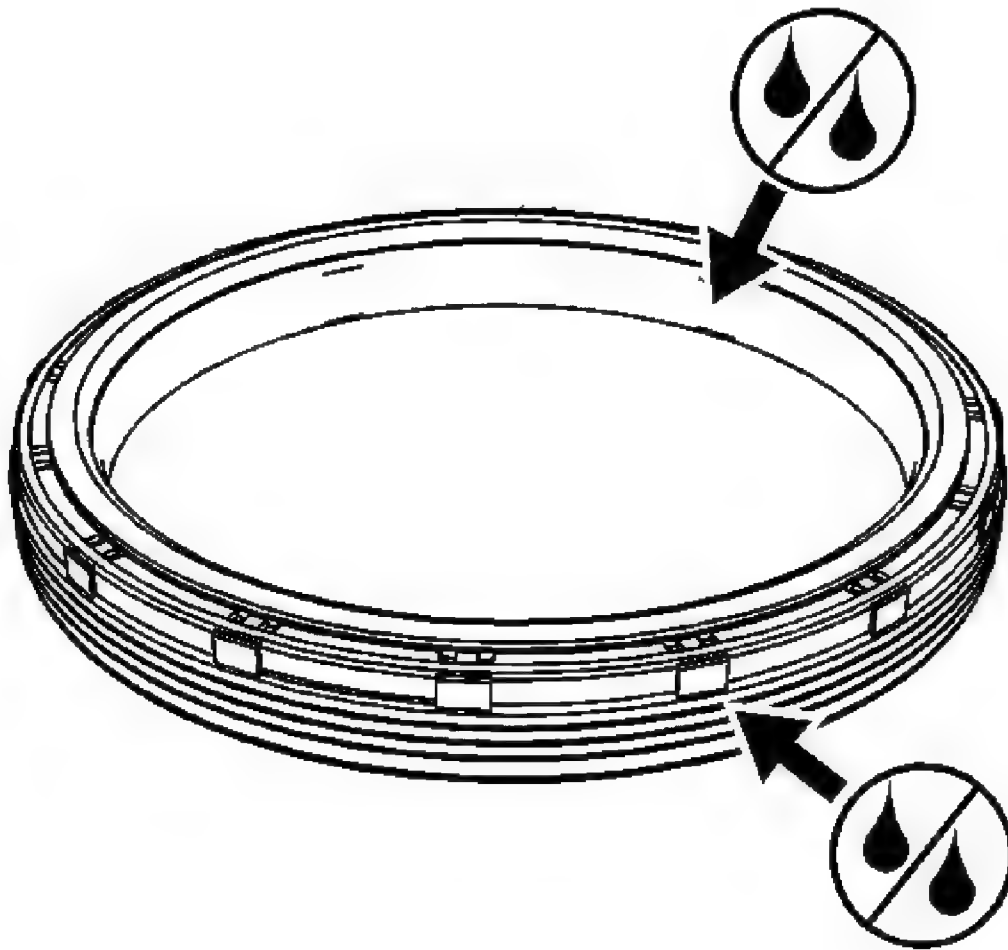


Fig. 172: Identifying Rear Seal Lubrication Points
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT use any lubricant in order to install the crankshaft rear oil seal. Do not use any lubricant on the coating pre-applied to the inner diameter of the crankshaft rear oil seal. The coating is a sealant that must not be contaminated. Do not use any lubricant on the outer diameter of the crankshaft rear oil seal. The sealant applied to the bore of the engine block will not properly bond to a lubricated crankshaft rear oil seal.

18. Do not lubricate any part of the new cassette style crankshaft rear oil seal.

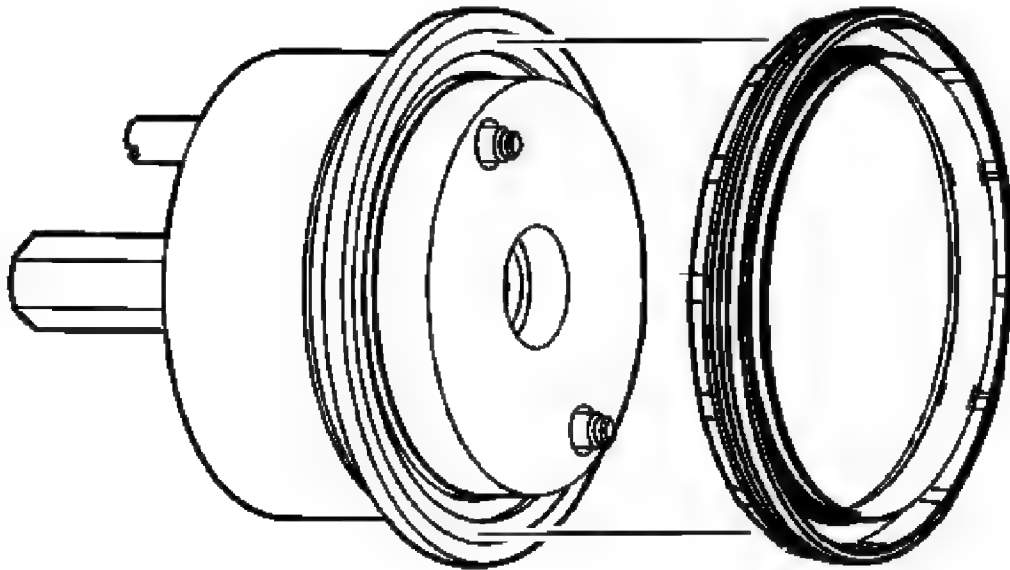


Fig. 173: Positioning Rear Seal Onto J 45930-A Crankshaft Rear Oil Seal Installer

Courtesy of GENERAL MOTORS CORP.

19. Install the new cassette style crankshaft rear oil seal onto the center hub of the **J 45930-A** . See **Special Tools** .

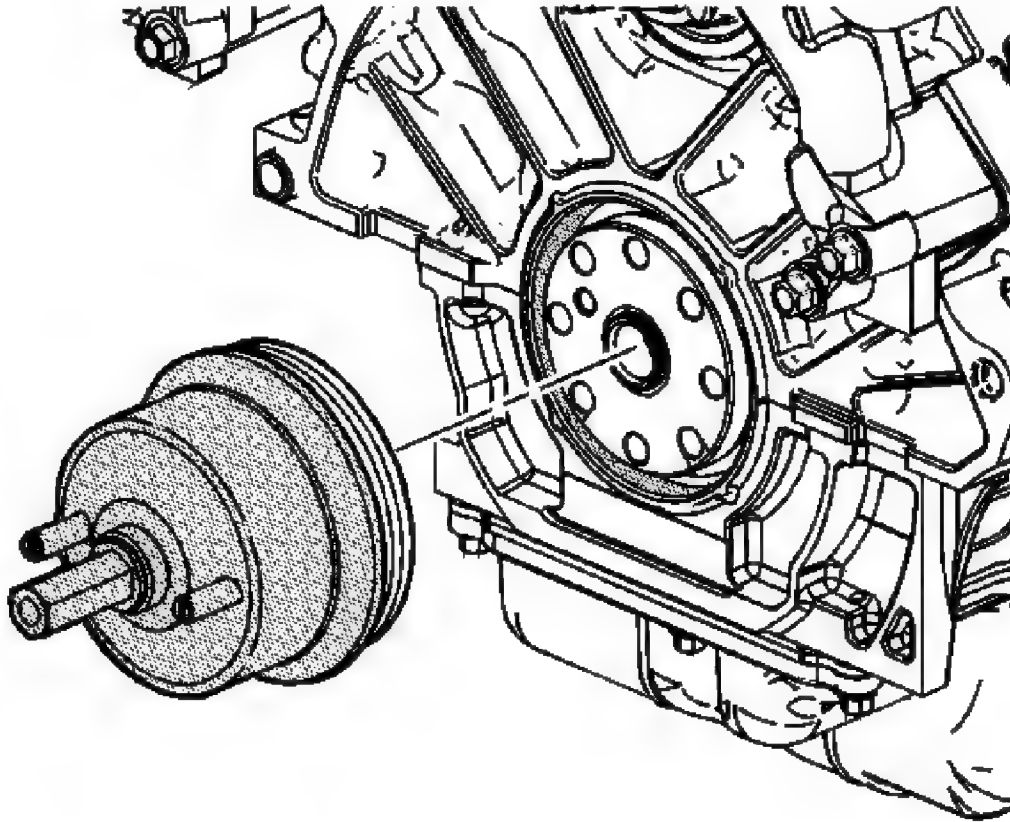


Fig. 174: Threading J 45930-A Mounting Bolts Into Crankshaft
Courtesy of GENERAL MOTORS CORP.

20. Thread the two **J 45930-A** mounting bolts into the crankshaft flywheel bolt holes. See **Special Tools** .

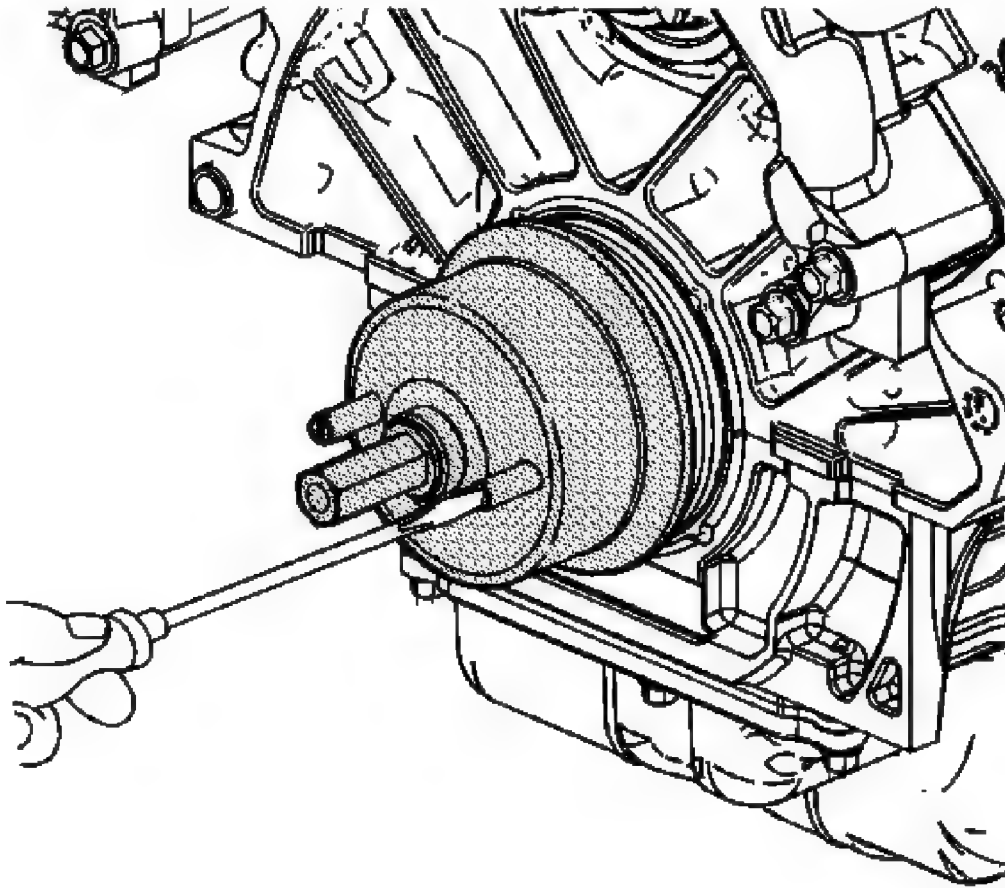


Fig. 175: Checking Seal Installer Tightness
Courtesy of GENERAL MOTORS CORP.

21. Tighten the two mounting bolts until the **J 45930-A** is firmly mounted on the crankshaft.
See **Special Tools** .

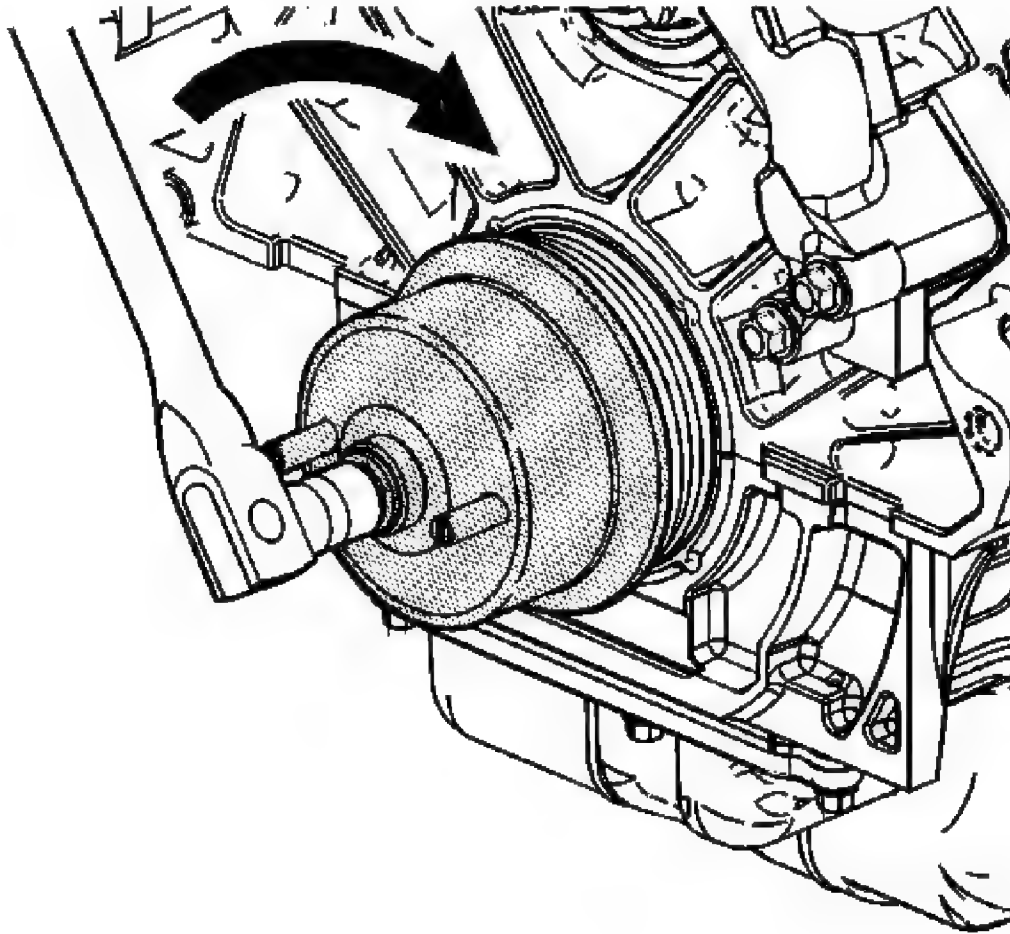


Fig. 176: Installing Crankshaft Rear Seal
Courtesy of GENERAL MOTORS CORP.

22. Install the new cassette style crankshaft rear oil seal by turning the nut of the **J 45930-A** until the drive portion of the **J 45930-A** bottoms against the crankcase. See **Special Tools** .

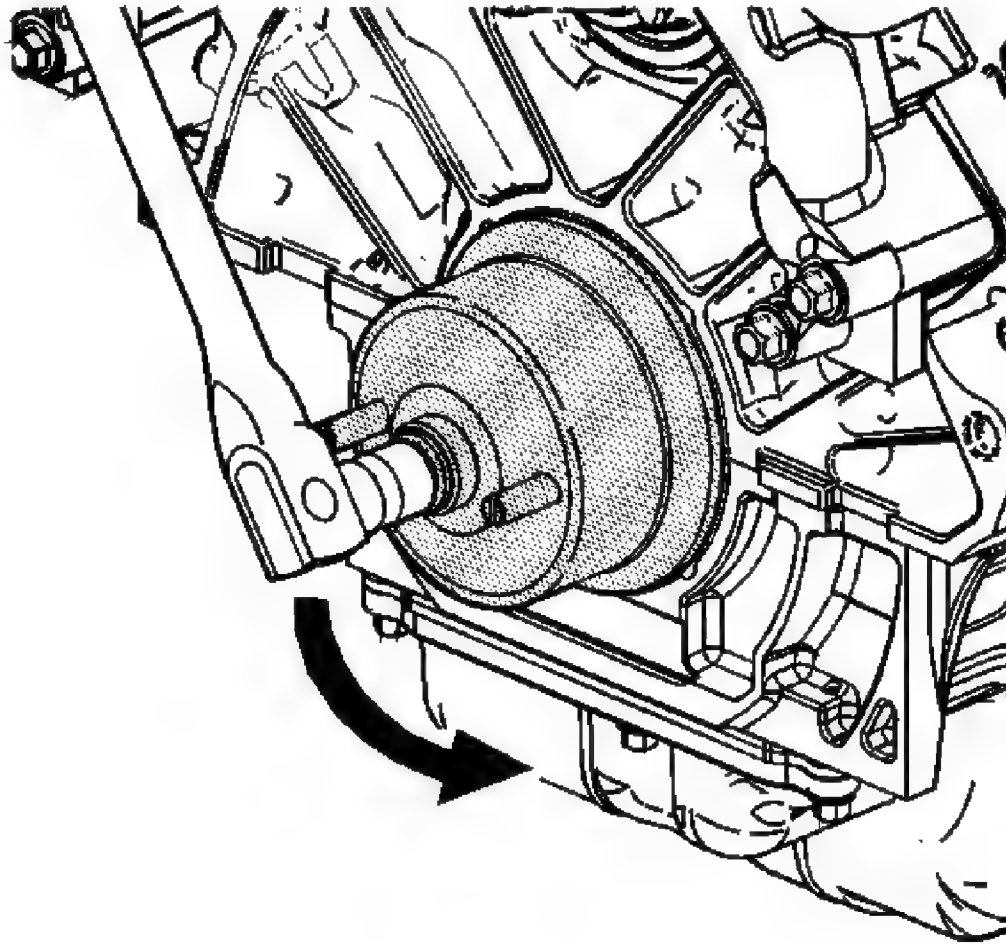


Fig. 177: Loosening Seal Installer Center Nut
Courtesy of GENERAL MOTORS CORP.

23. Loosen the center nut to release pressure on the crankcase.

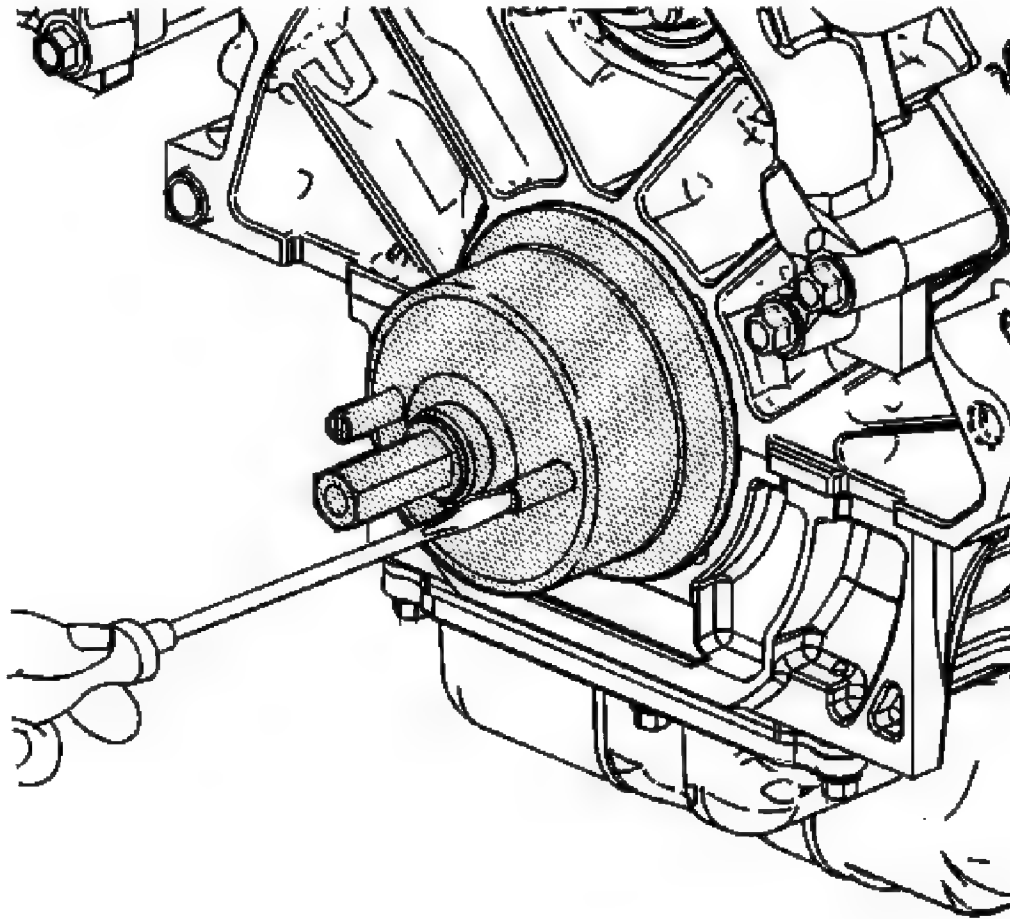


Fig. 178: Loosening Seal Installer Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

24. Loosen the two mounting bolts.

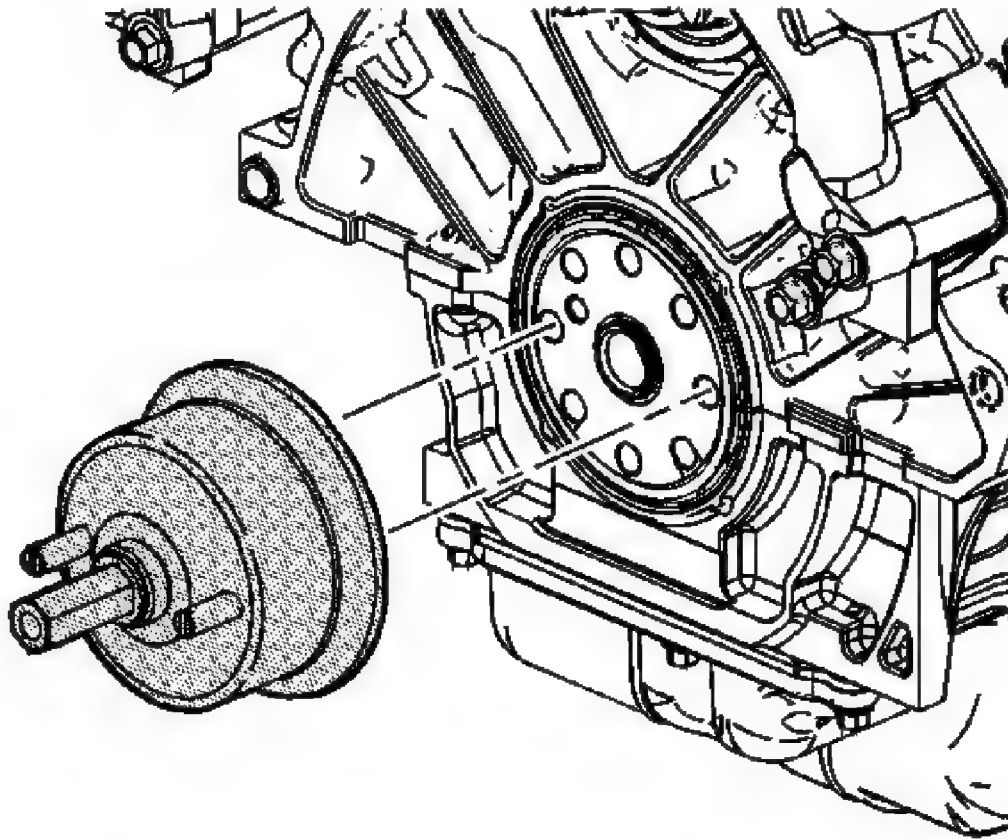


Fig. 179: Removing J 45930-A Seal Installer
Courtesy of GENERAL MOTORS CORP.

25. Remove the **J 45930-A** from the crankshaft. See **Special Tools** .
26. Wipe off any excessive sealant from the block.

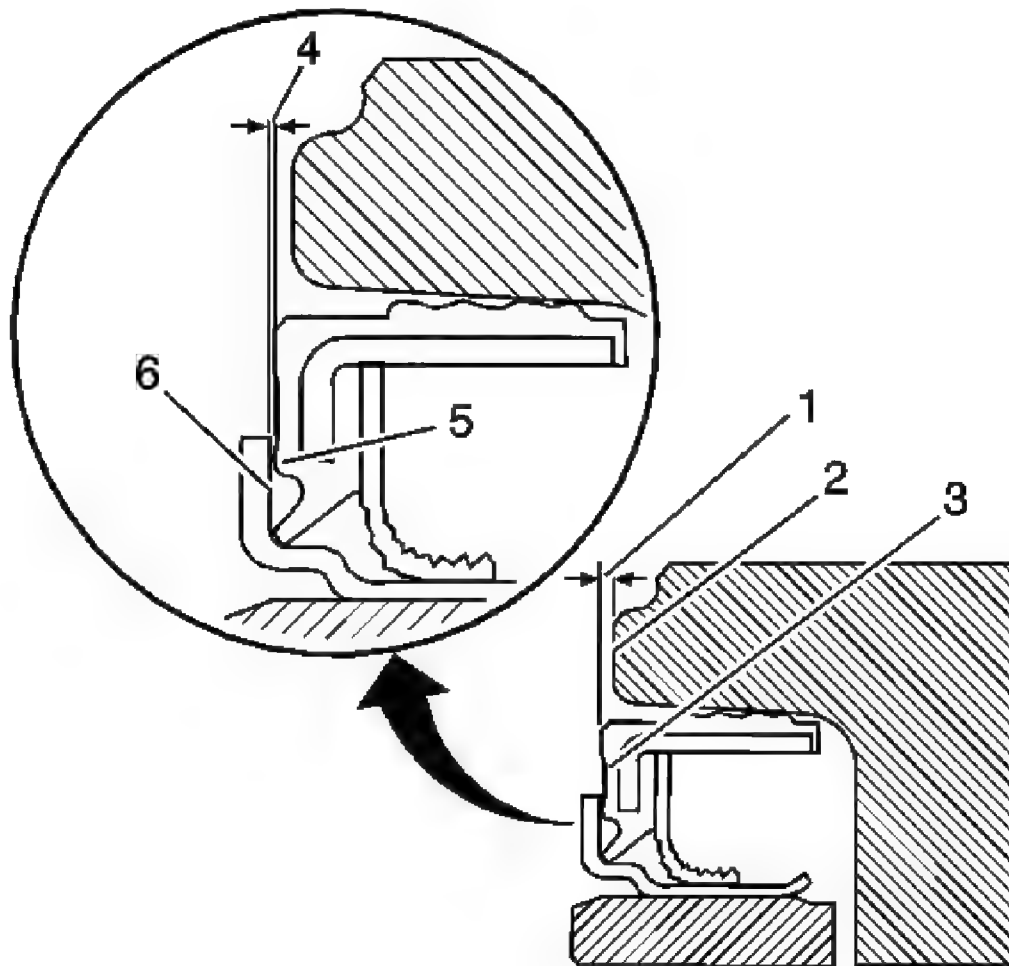


Fig. 180: Checking Seal Installation
Courtesy of GENERAL MOTORS CORP.

27. Ensure the new cassette style crankshaft rear oil seal is installed properly.
 - The outer surface of the seal (3) should be 0.500-0.800 mm (0.0197-0.0315 in) (1) below the surface of the engine block (2).
 - The inner surface of the sleeve (6) should be 0.400-0.900 mm (0.0158-0.0354 in) (4) below the surface of the outer surface of the seal (5).
 - The installed seal and sleeve need to be parallel to the block by 0.000-0.500 mm (0.000-0.0197 in).
28. Clean all tools to remove any residual sealant.

ENGINE FLYWHEEL INSTALLATION

TOOLS REQUIRED

- **J 44214** Flywheel Holder. See **Special Tools** .
- **J 45059** Angle Meter

INSTALLATION PROCEDURE

1. Apply sealant, GM P/N 12346004, (Canadian P/N 10953480) or equivalent, to the engine flywheel bolts.

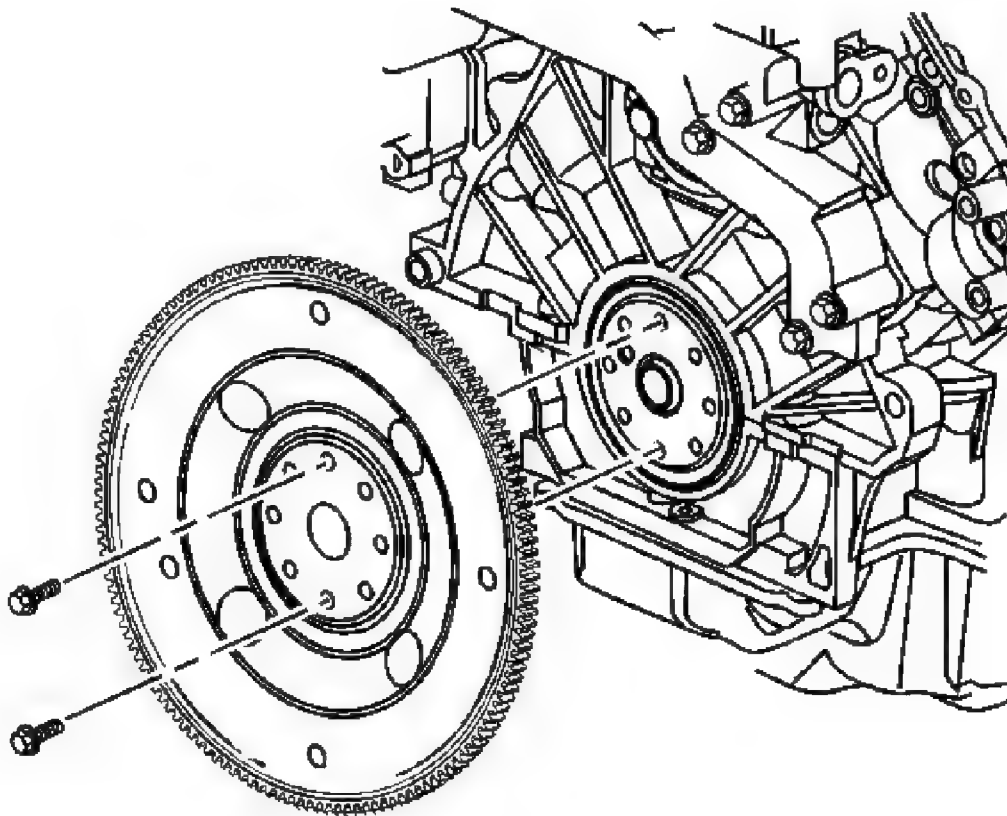


Fig. 181: Identifying 8 Engine Flywheel Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

2. Place the engine flywheel in position on the crankshaft.
3. Loosely install a bolt at the top and bottom of the bolt circle allowing the engine flywheel to hang in position.

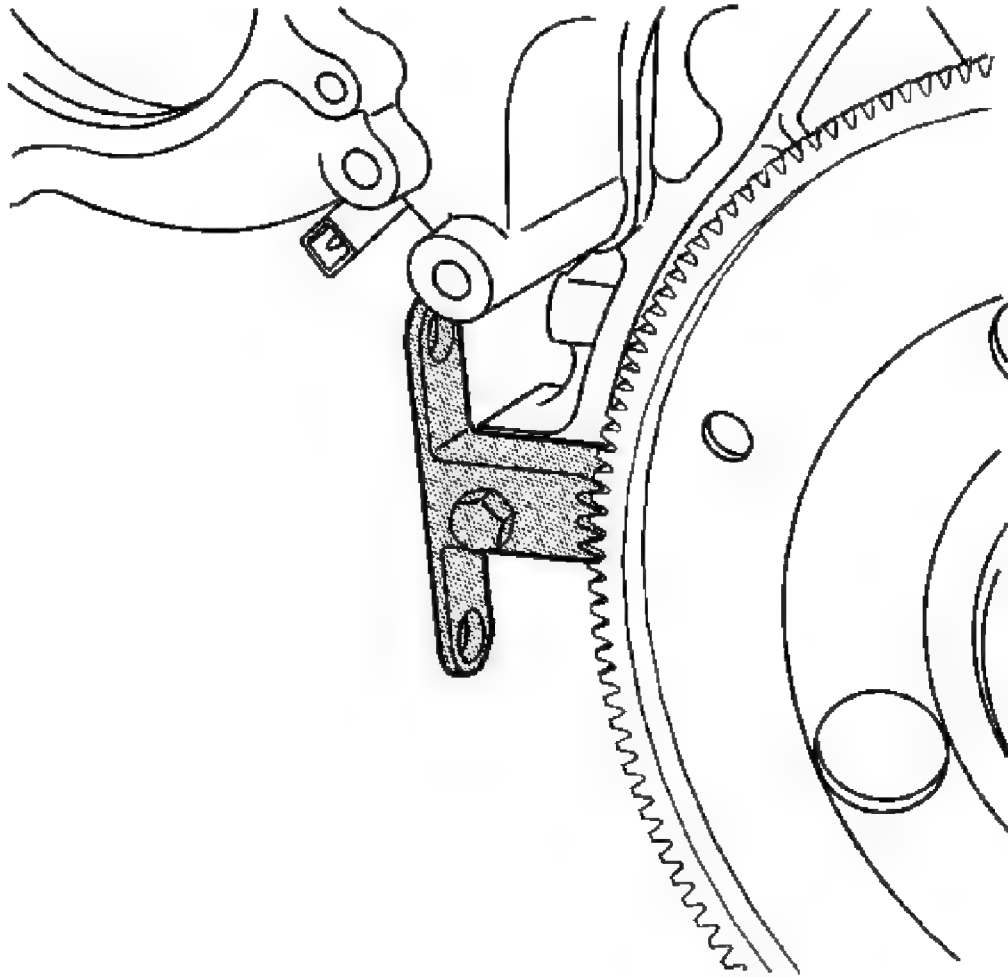


Fig. 182: Locating J 44214 Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 44214** to the engine block. See **Special Tools** .
5. Install the remaining engine flywheel bolts.

NOTE: Refer to **Fastener Notice** .

6. Tighten the engine flywheel bolts.
 1. First Pass

Tighten: Tighten the engine flywheel retaining bolts to 30 N.m (22 lb ft).

2. Final Pass

Tighten: Tighten the engine flywheel retaining bolts an additional 50 degrees using the J 45059 .

CRANKSHAFT BALANCER INSTALLATION

TOOLS REQUIRED

- J 41998-B Crankshaft Balancer Installer. See Special Tools .
- J 45059 Angle Meter
- J 44214 Flywheel Holder. See Special Tools .

INSTALLATION PROCEDURE

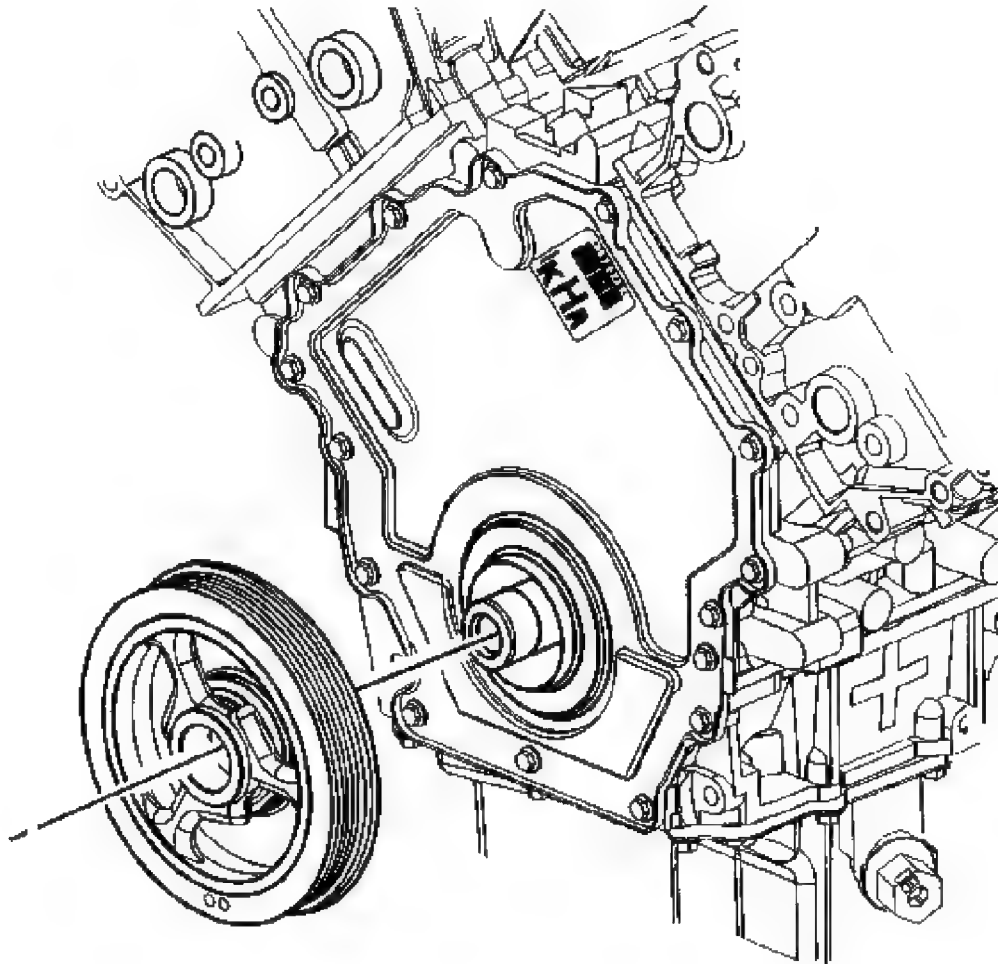


Fig. 183: View of Crankshaft Balancer

Courtesy of GENERAL MOTORS CORP.

1. Position the crankshaft balancer on the nose of the crankshaft.

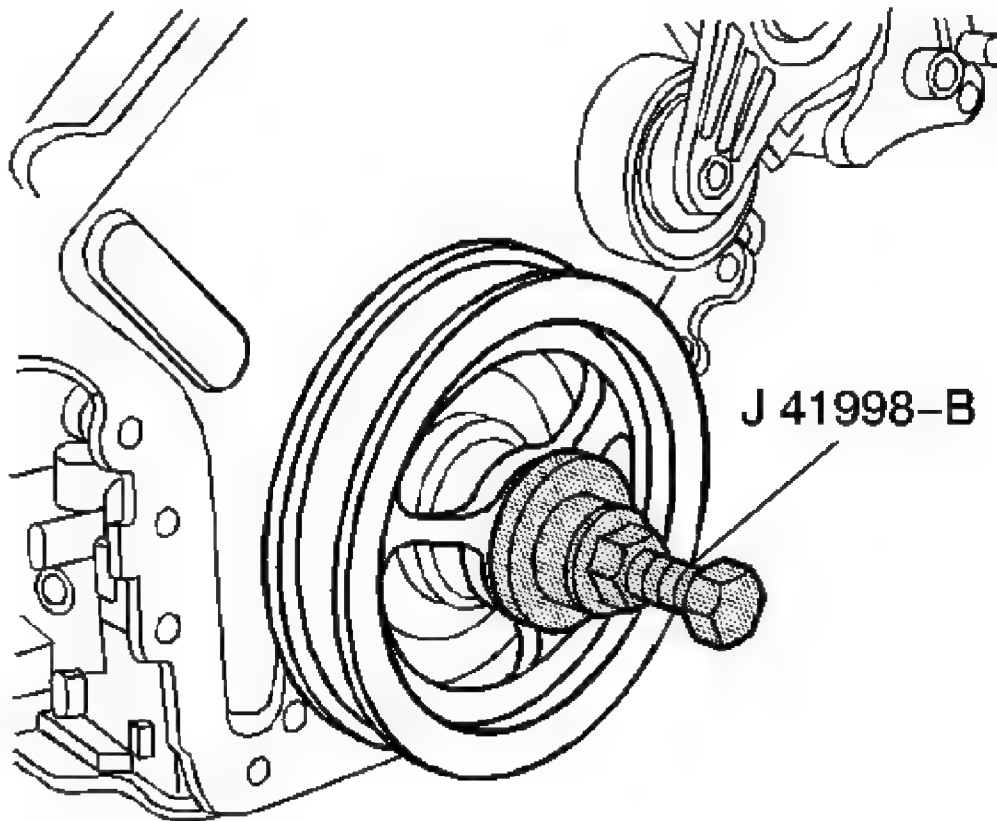


Fig. 184: Identifying J 41998-A Installing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

2. Press the crankshaft balancer in place using the J 41998-B . See Special Tools .

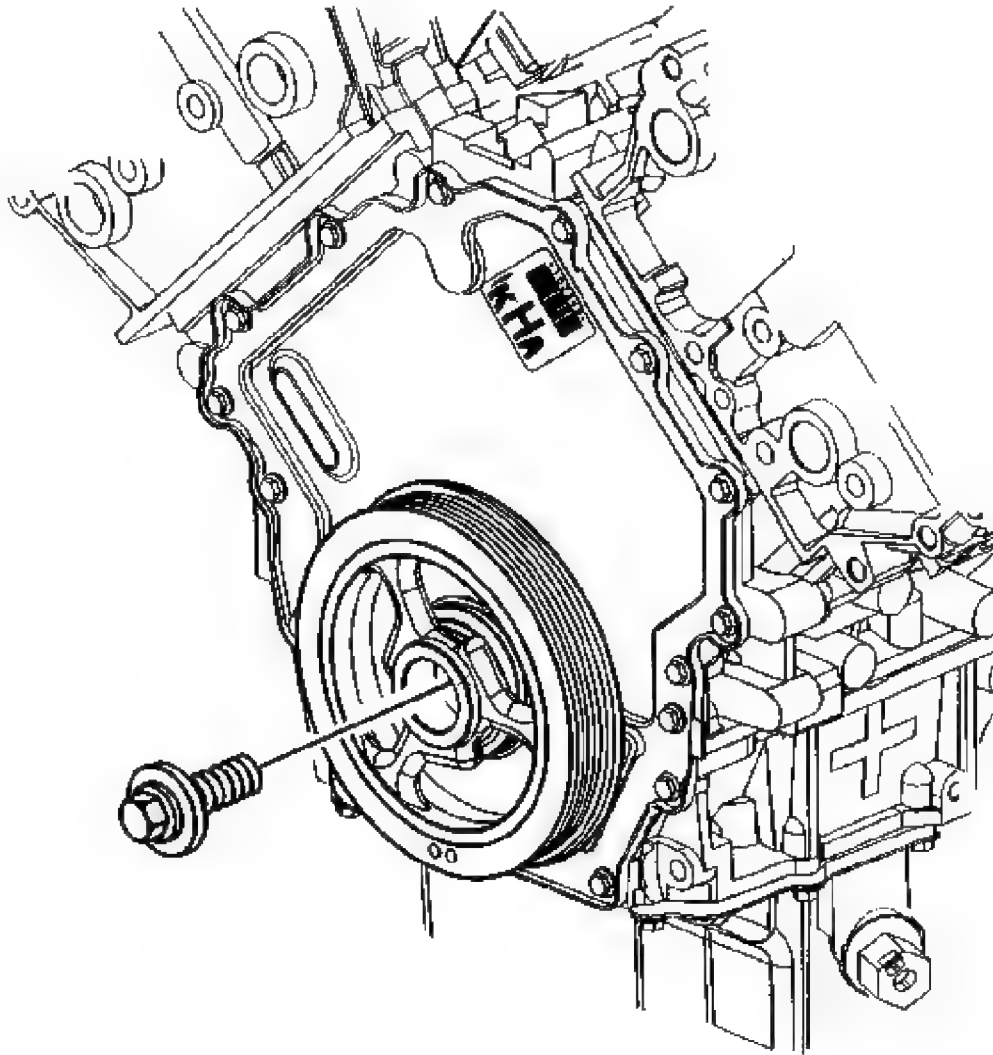


Fig. 185: View of Crankshaft Balancer Bolt Threads
Courtesy of GENERAL MOTORS CORP.

3. Clean the crankshaft balancer bolt threads.
4. Apply engine oil to the crankshaft balancer bolt threads.

NOTE: Refer to Fastener Notice .

5. Install the crankshaft balancer bolt.
 1. First Pass

Tighten: Tighten the crankshaft balancer bolt to 50 N.m (37 lb ft).

2. Final Pass

Tighten: Tighten the crankshaft balancer bolt an additional 150 degrees using the **J 45059** .

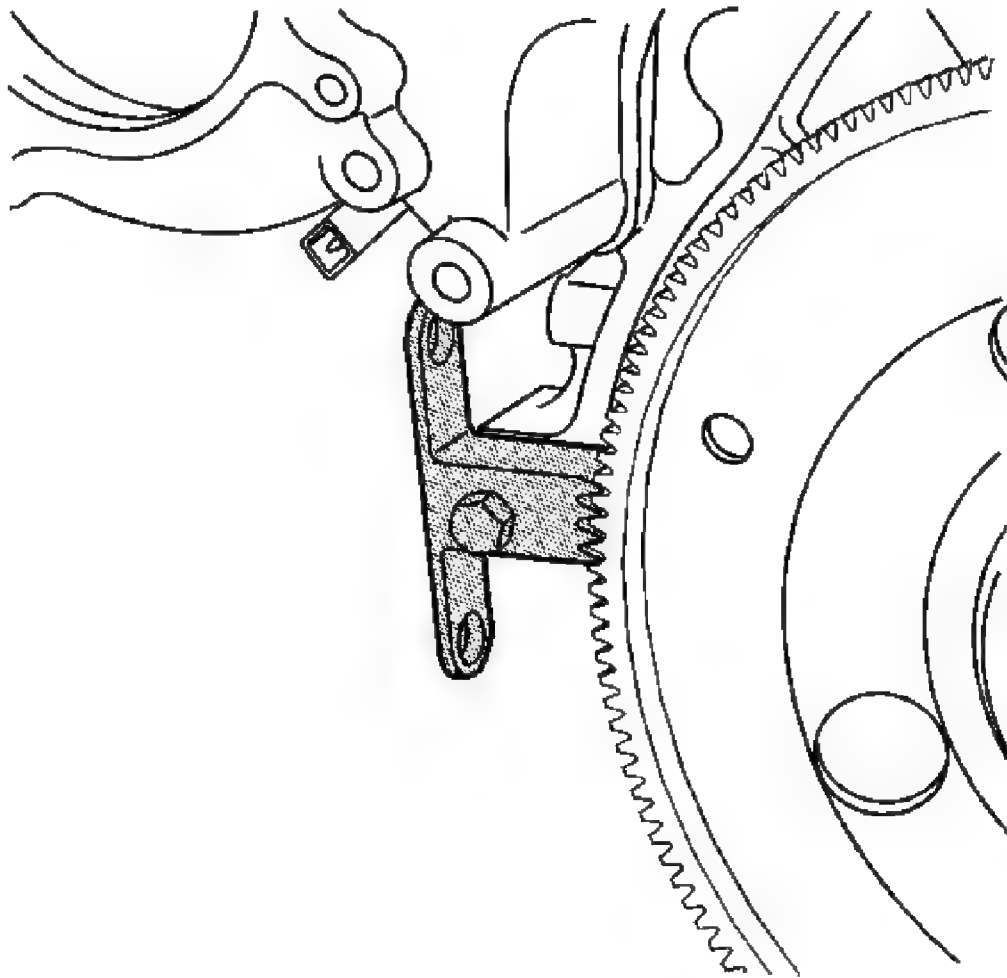


Fig. 186: Locating J 44214 Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

6. Remove the **J 44214** from the engine block. See **Special Tools** .

DRIVE BELT TENSIONER INSTALLATION

INSTALLATION PROCEDURE

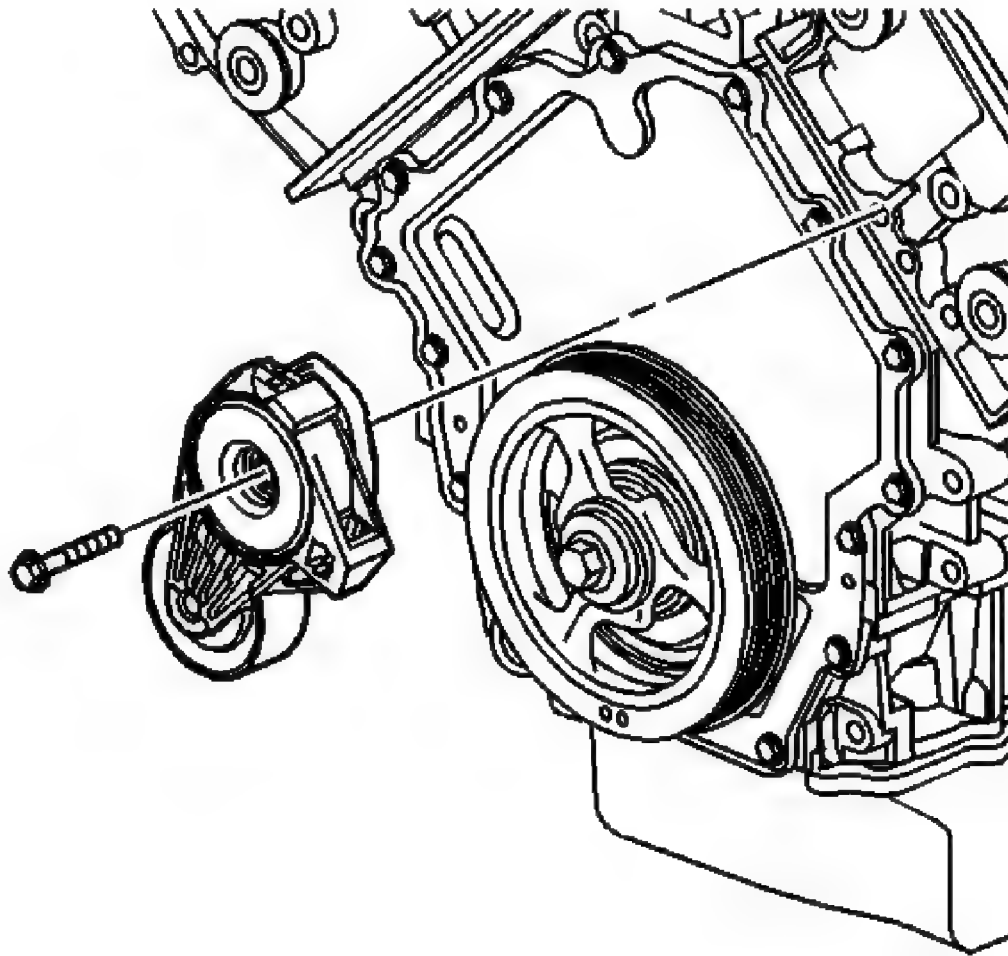


Fig. 187: View Of Drive Belt Tensioner & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner. Be sure to locate the tensioner anchor pin in the cylinder head recess.

NOTE: Refer to FASTENER NOTICE .

2. Install the drive belt tensioner bolt.

Tighten: Tighten the drive belt tensioner bolt to 50 N.m (37 lb ft).

DRIVE BELT IDLER PULLEY INSTALLATION

INSTALLATION PROCEDURE

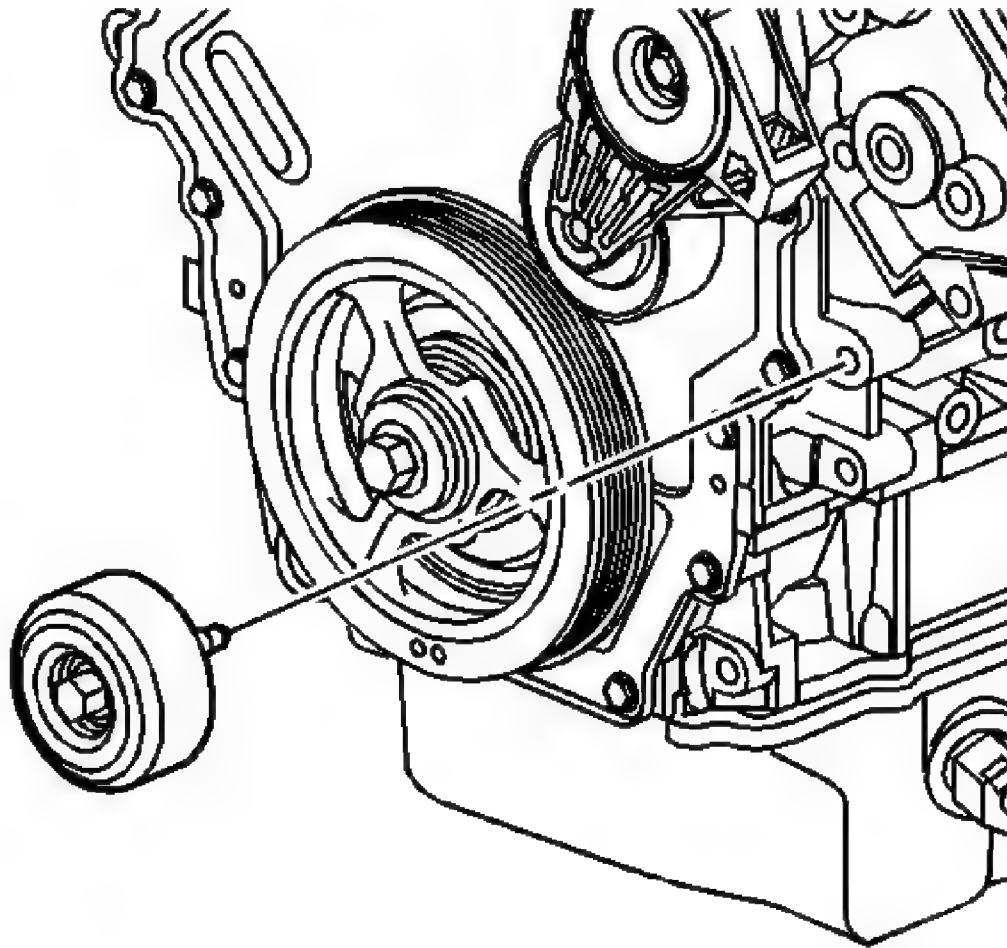


Fig. 188: View of Drive Belt Idler Pulley Bolt
Courtesy of GENERAL MOTORS CORP.

1. Place the drive belt idler pulley and bolt in position.

NOTE: Refer to FASTENER NOTICE .

2. Tighten the drive belt idler pulley bolt.

Tighten: Tighten the drive belt idler pulley bolt to 50 N.m (37 lb ft).

AIR CONDITIONING (A/C) COMPRESSOR INSTALLATION

INSTALLATION PROCEDURE

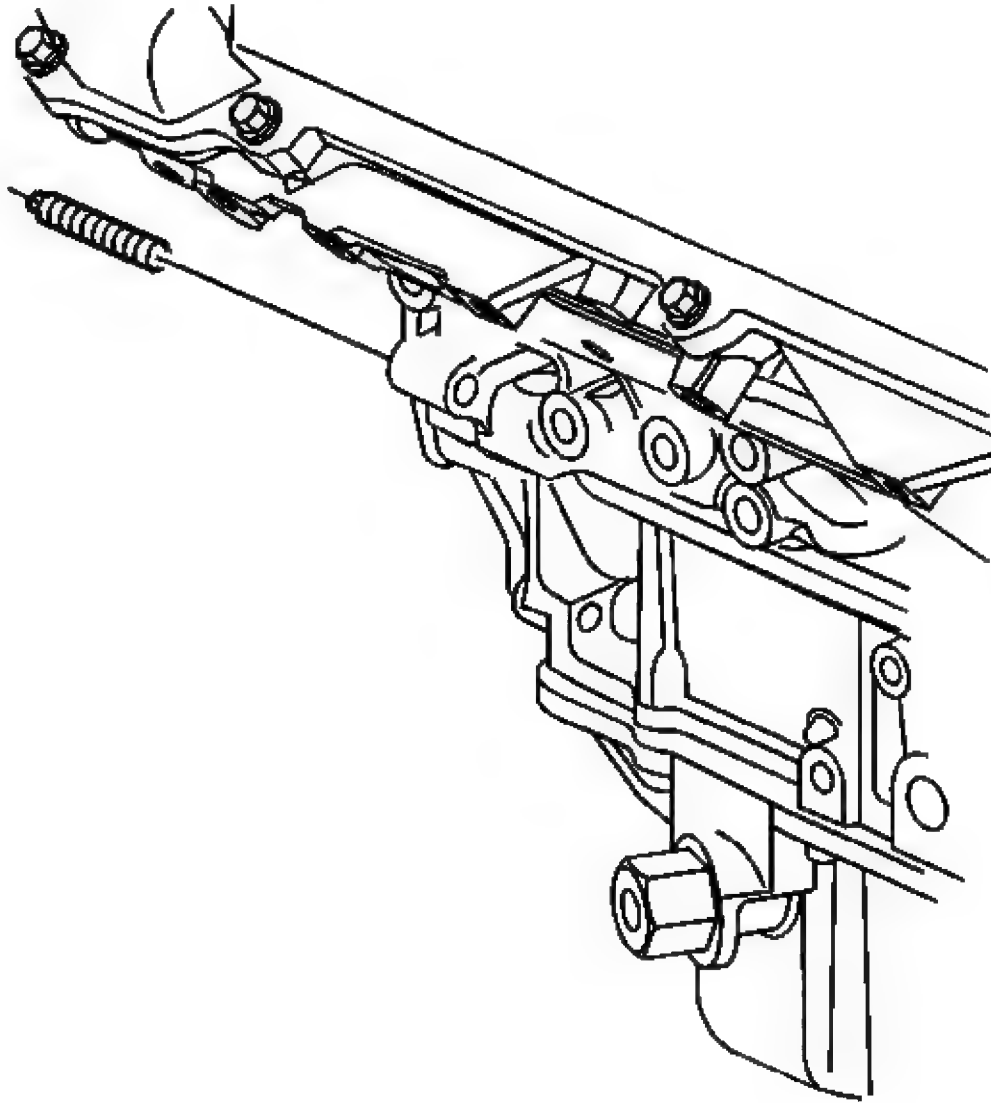


Fig. 189: Identifying Air Conditioning Compressor Stud
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the air conditioning compressor stud.

Tighten: Tighten the air conditioning compressor stud to 25 N.m (18 lb ft).

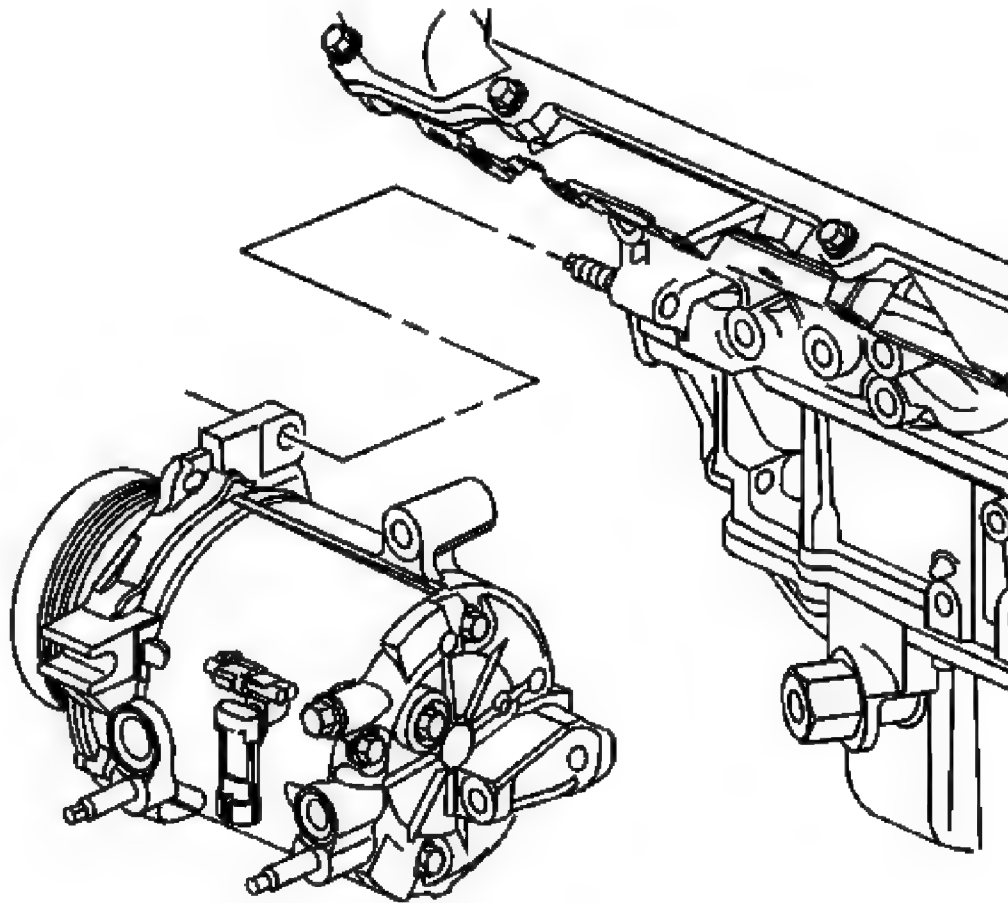


Fig. 190: View of Air Conditioning Compressor
Courtesy of GENERAL MOTORS CORP.

2. Slide the air conditioning compressor over the air conditioning compressor stud and hold in position.

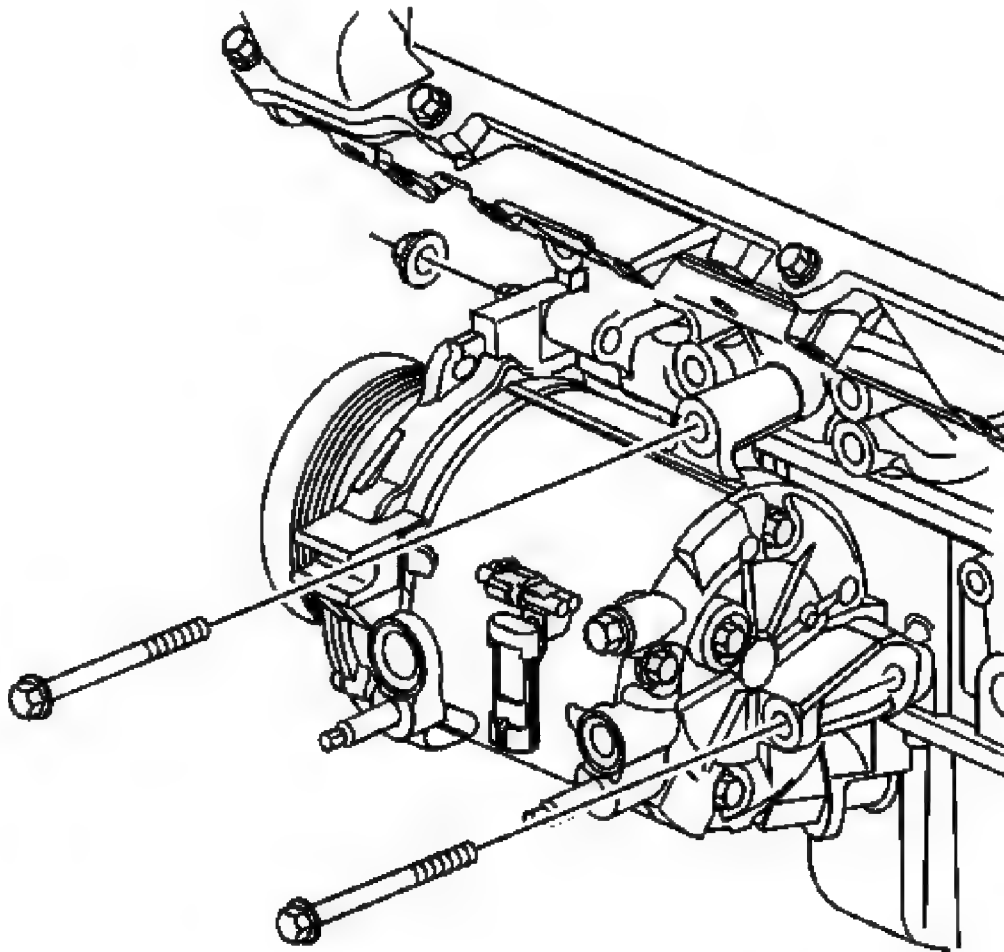


Fig. 191: View of Air Conditioning Compressor Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the front air conditioning compressor bolt finger tight.

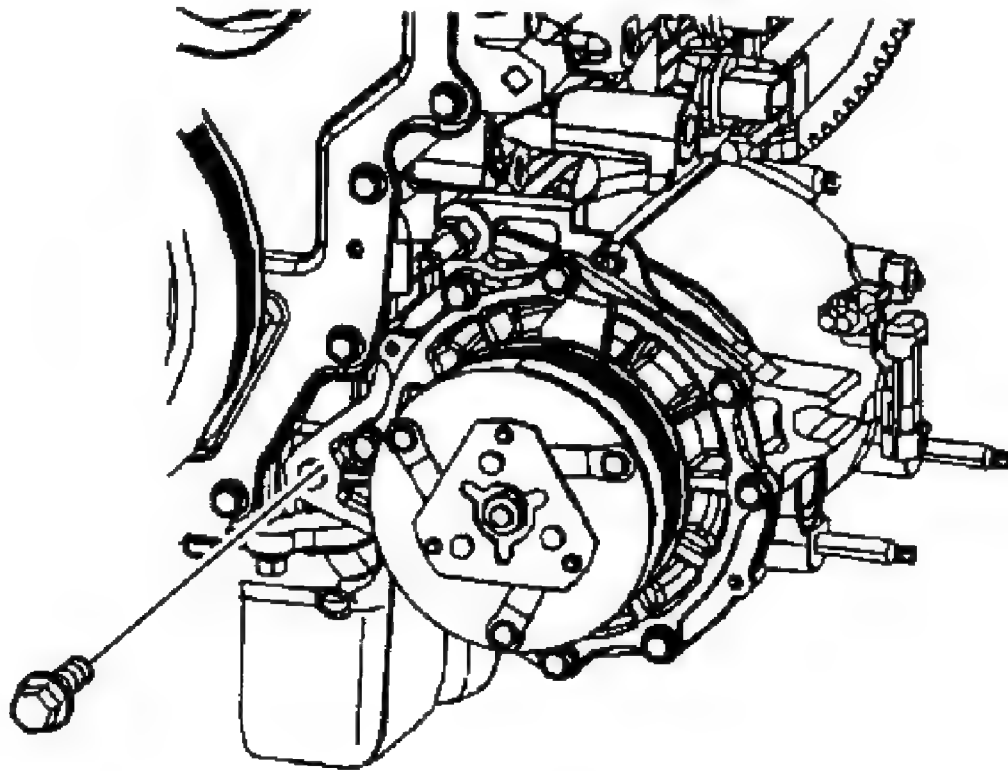


Fig. 192: View of Air Conditioning Compressor Front Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the front air conditioning compressor nut finger tight.
5. Install the side air conditioning compressor bolts finger tight.

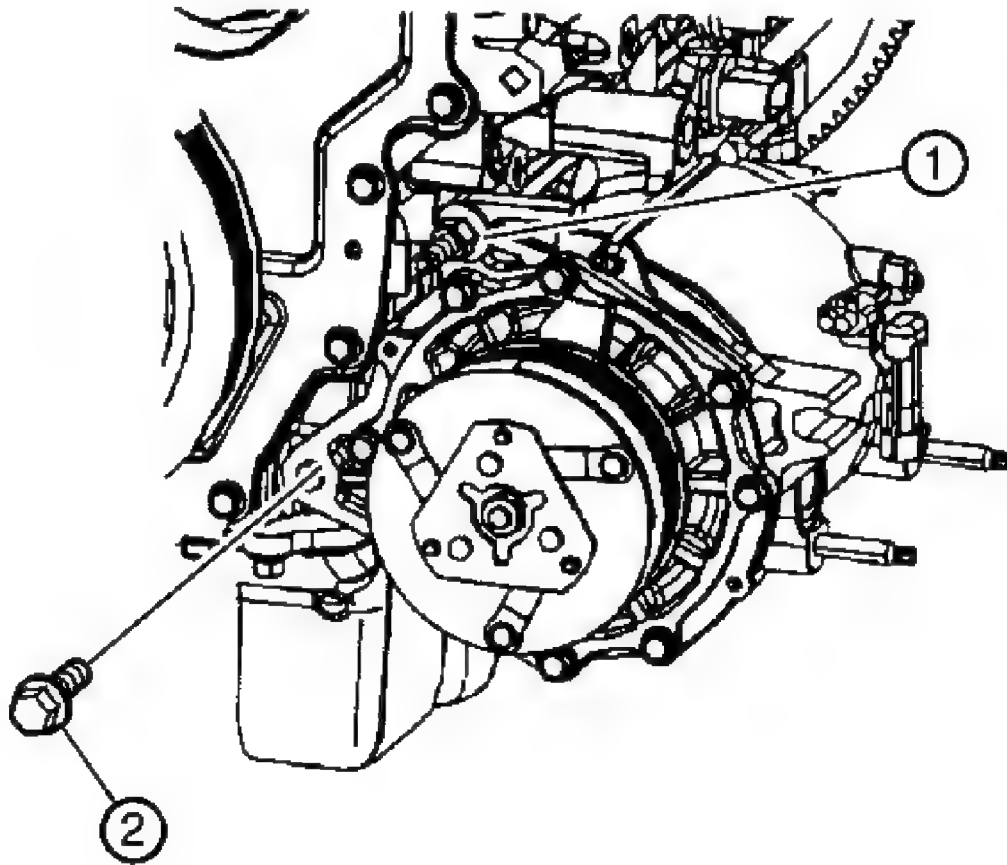


Fig. 193: Identifying Front Air Conditioning Compressor Fasteners Tightening Sequence

Courtesy of GENERAL MOTORS CORP.

6. Tighten the front air conditioning compressor fasteners in sequence.

Tighten: Tighten the front air conditioning compressor fasteners to 50 N.m (36 lb ft).

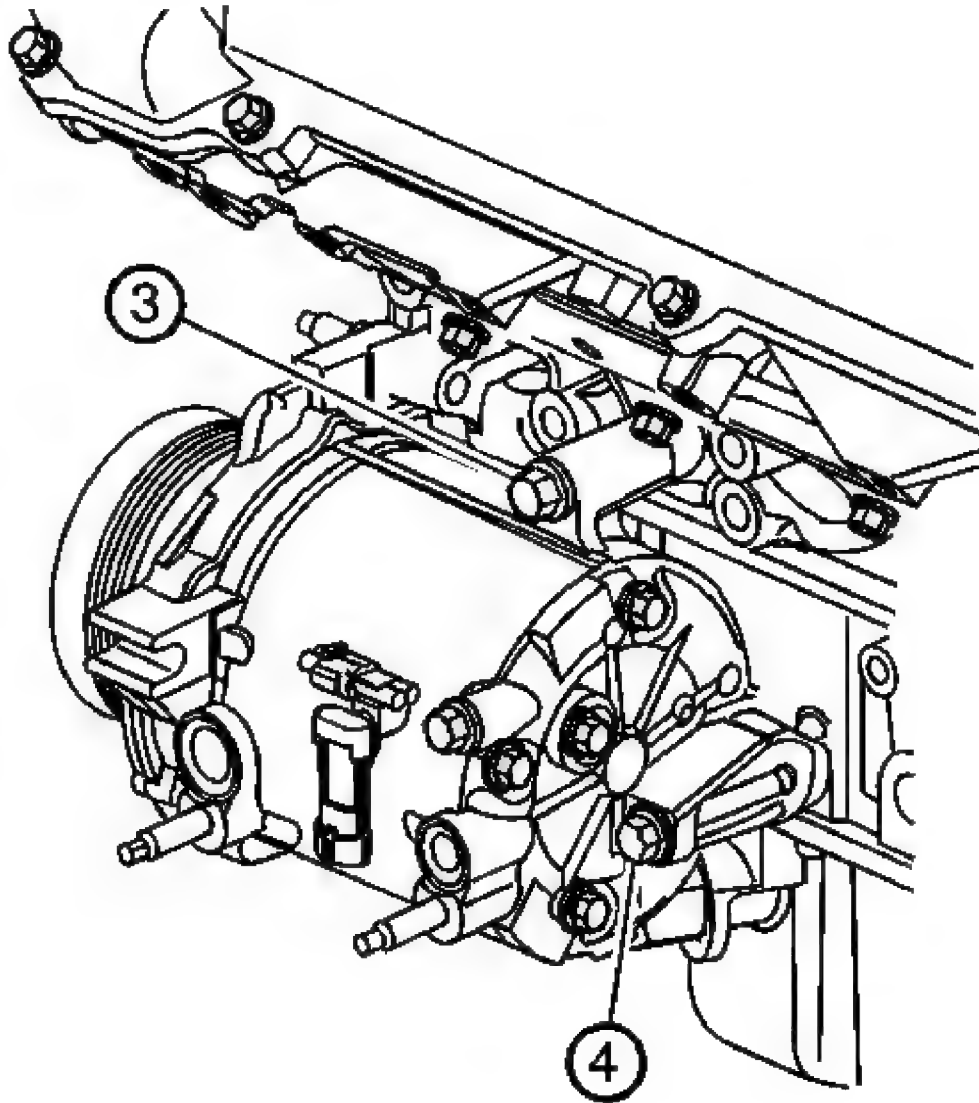


Fig. 194: Identifying Side Air Conditioning Compressor Fasteners Tightening Sequence

Courtesy of GENERAL MOTORS CORP.

7. Tighten the side air conditioning compressor fasteners in sequence.

Tighten:

1. Tighten the side upper air conditioning compressor bolt to 50 N.m (36 lb ft).
2. Tighten the side lower/rear air conditioning compressor bolt to 25 N.m (18 lb ft).

GENERATOR INSTALLATION

INSTALLATION PROCEDURE

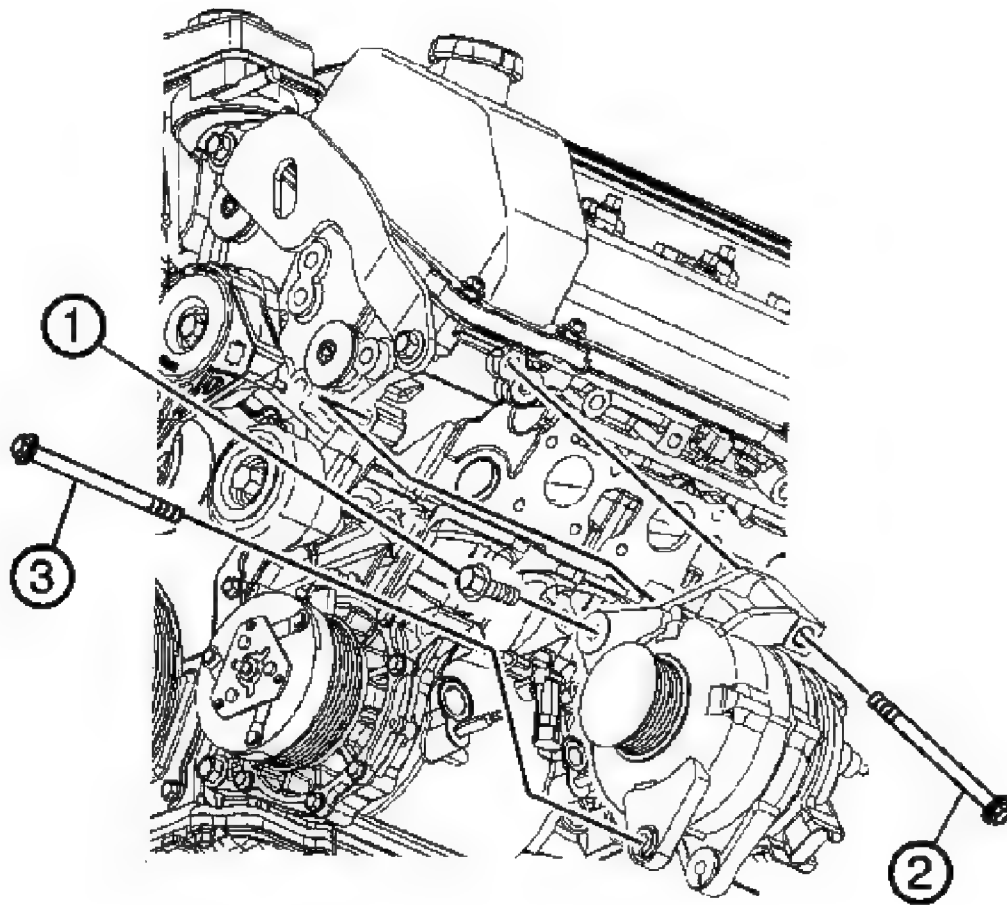


Fig. 195: View of Generator Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

1. Place the generator in position.
2. Install the generator side bolt finger tight.
3. Install the generator front bolts finger tight.

NOTE: Refer to Fastener Notice .

4. Tighten the generator bolts in the sequence shown.

Tighten:

1. Tighten the generator front upper bolt to 50 N.m (37 lb ft).
2. Tighten the generator side bolt to 50 N.m (37 lb ft).
3. Tighten the generator front lower bolt to 50 N.m (37 lb ft).

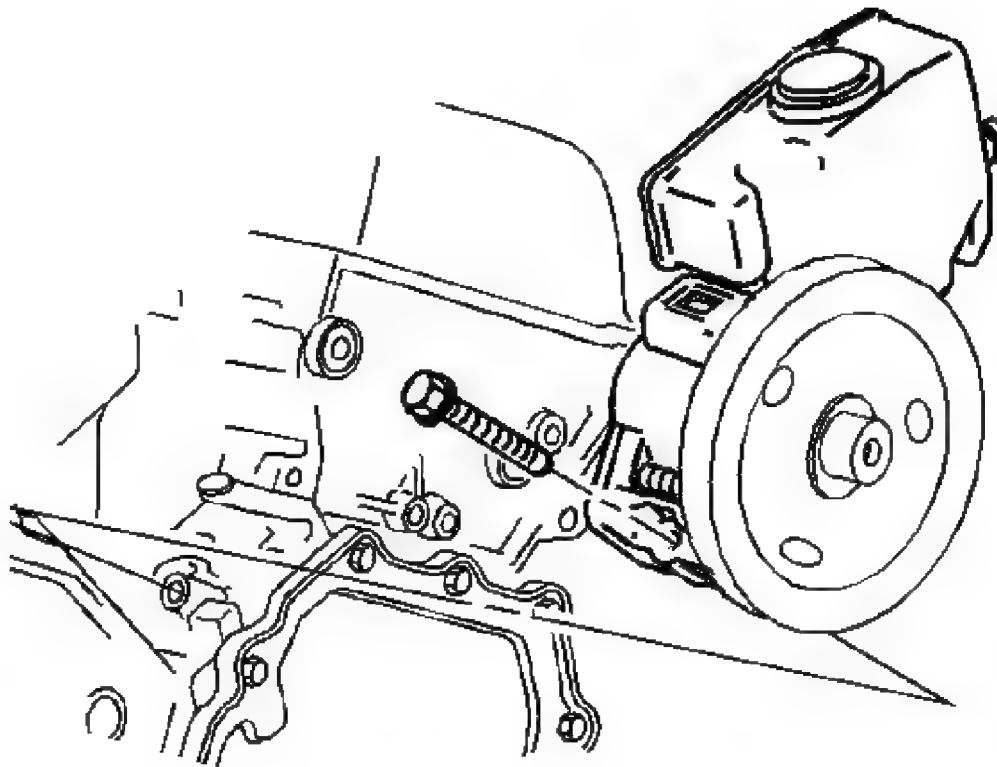
POWER STEERING PUMP INSTALLATION**INSTALLATION PROCEDURE**

Fig. 196: Identifying Power Steering Pump Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Place the power steering pump in position in the engine valley. Slide the molded wedge into the retaining feature cast into the cylinder block.

NOTE: Refer to FASTENER NOTICE .

IMPORTANT: You **MUST** push the power steering pump toward the rear

of the engine as much as possible before tightening the bolt.

2. Install the power steering pump bolt.

Tighten: Tighten the power steering pump bolt to 50 N.m (37 lb ft).

DRIVE BELT INSTALLATION

INSTALLATION PROCEDURE

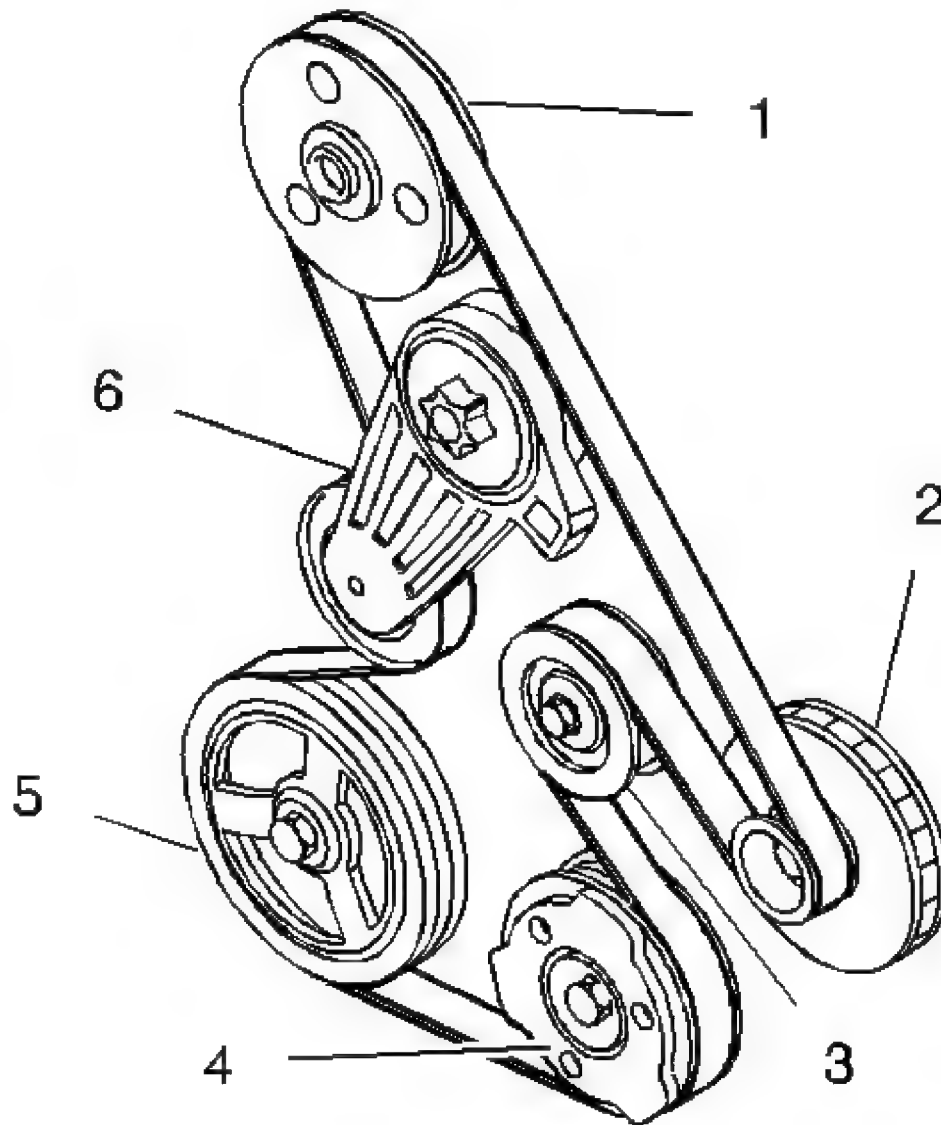


Fig. 197: Identifying Power Steering Pulleys, Drive Belt & Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Route the accessory drive belt around the crankshaft (5), the air conditioning compressor (4), the idler (3), the generator (2) and the drive belt tensioner (6) pulleys.
2. Insert a 1/2 inch drive ratchet into the drive belt tensioner (6).
3. Rotate the tensioner clockwise.
4. Route the remainder of the belt around the power steering pulley (1).
5. Slowly rotate the drive belt tensioner counter clockwise until the drive belt is tight.

6. Remove the 1/2 inch drive ratchet.
7. Check the drive belt for proper seating in all pulleys.

ENGINE PRELUBING

TOOLS REQUIRED

- **J 42907** Oil Pressure Tester. See **Special Tools** .
- **J 45299** Engine Preluber

INSTALLATION PROCEDURE

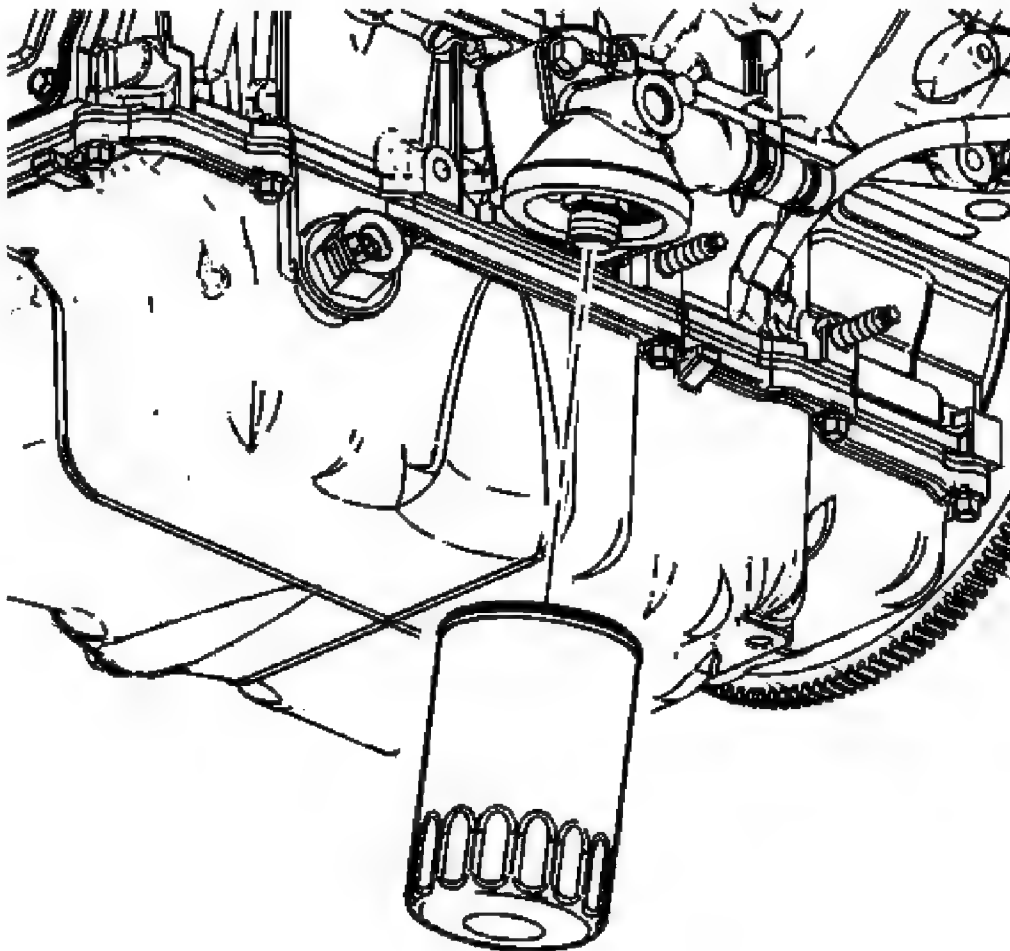


Fig. 198: View Of Oil Filter
Courtesy of **GENERAL MOTORS CORP.**

1. Remove the engine oil filter.

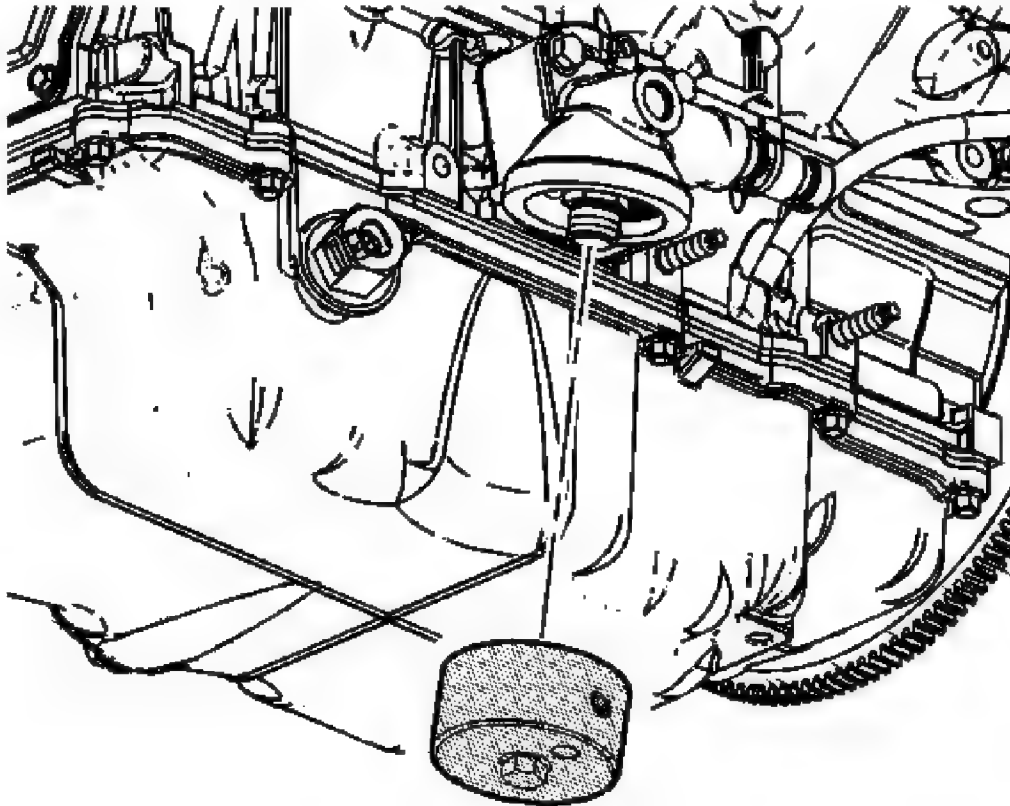


Fig. 199: View Of J 42907 Oil Pressure Tester
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 42907** onto the oil filter adapter. See **Special Tools** .

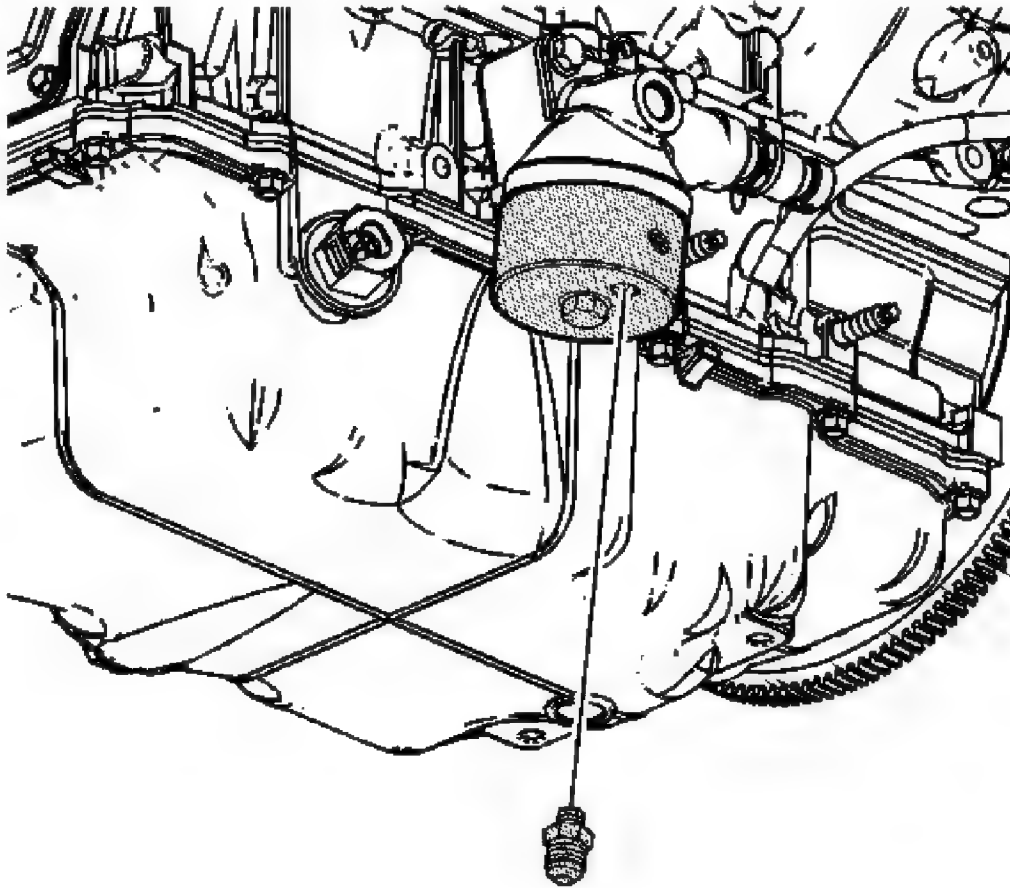


Fig. 200: View Of 1/8 NPT Fitting
Courtesy of GENERAL MOTORS CORP.

3. Install the 1/8 NPT fitting from the **J 45299** into the port on the **J 42907** . See **Special Tools** .

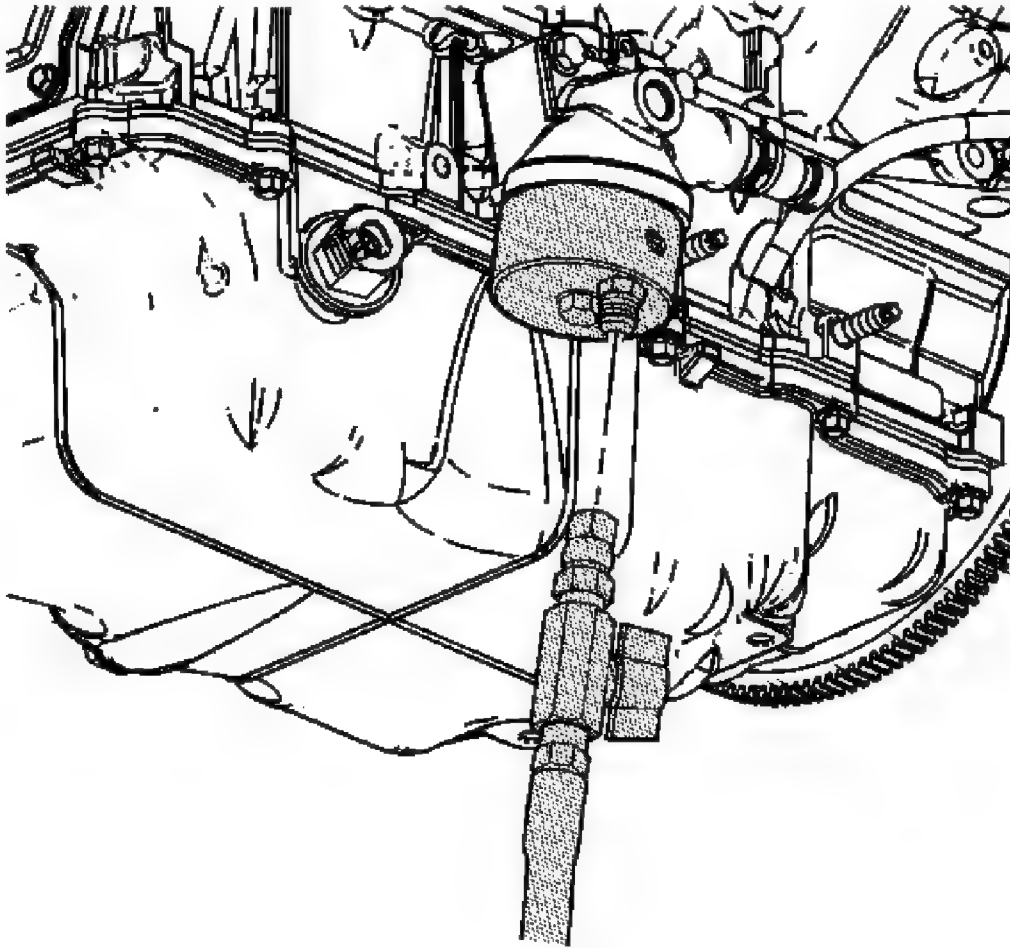


Fig. 201: View Of J 45299 Flexible Hose
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 45299** flexible hose to the fitting.

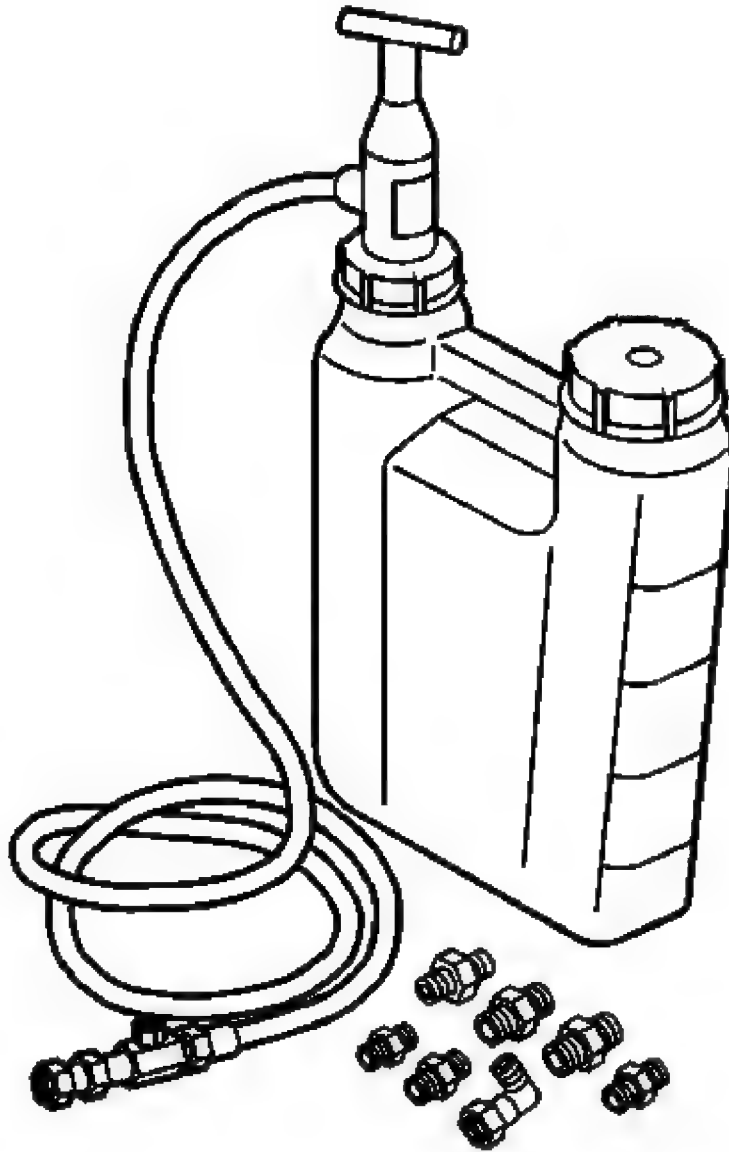


Fig. 202: Identifying Engine Preluber J 45299
Courtesy of GENERAL MOTORS CORP.

5. Open the valve of the J 45299 .

IMPORTANT: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Use the approved engine oil as specified in the owner's manual.

6. Pump the handle of the **J 45299** in order to flow a minimum of 1-1.9 liters (1-2 quarts) of fresh clean engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve of the **J 45299** .

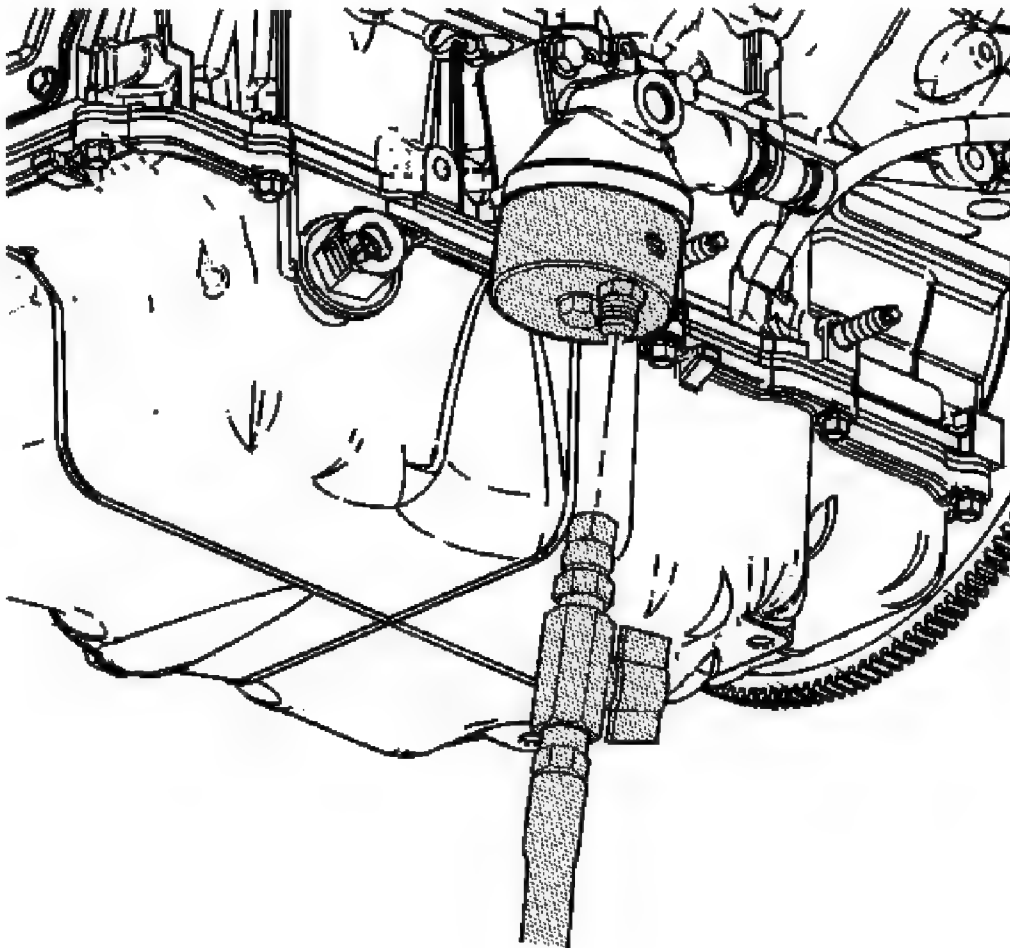


Fig. 203: View Of J 45299 Flexible Hose
Courtesy of GENERAL MOTORS CORP.

8. Remove the **J 45299** flexible hose.

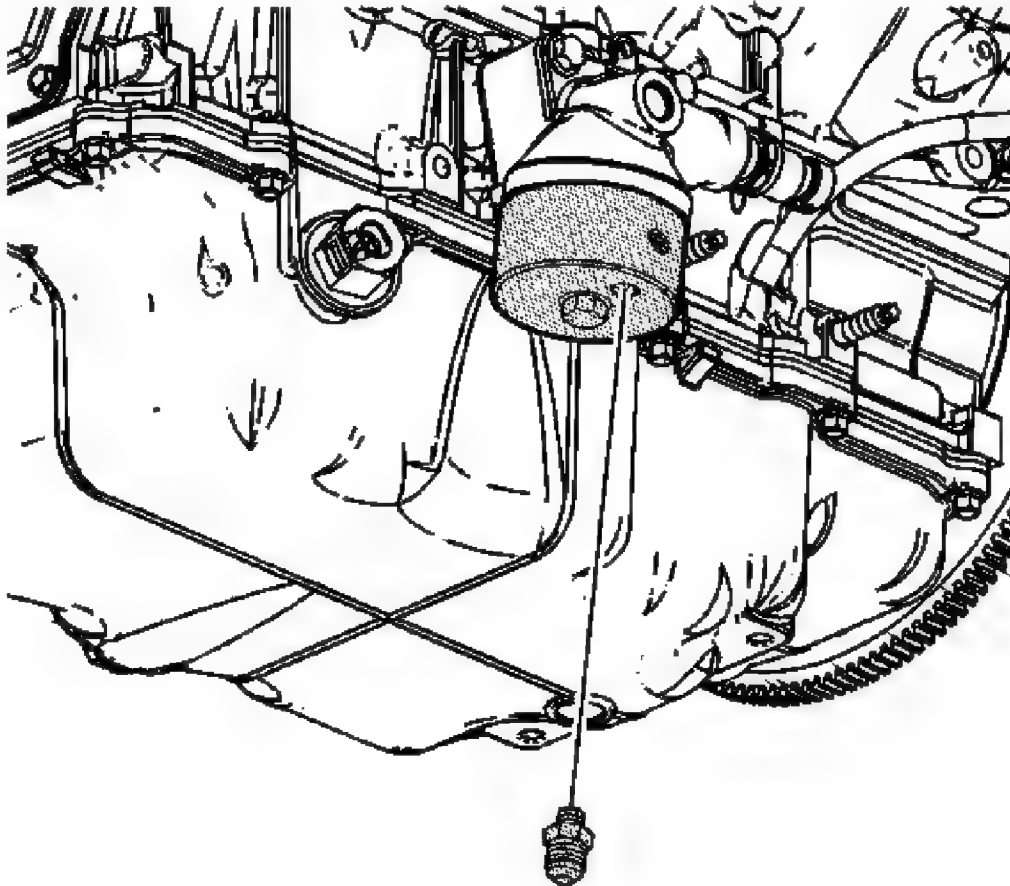


Fig. 204: View Of 1/8 NPT Fitting
Courtesy of GENERAL MOTORS CORP.

9. Remove the fitting from the J 42907 . See Special Tools .

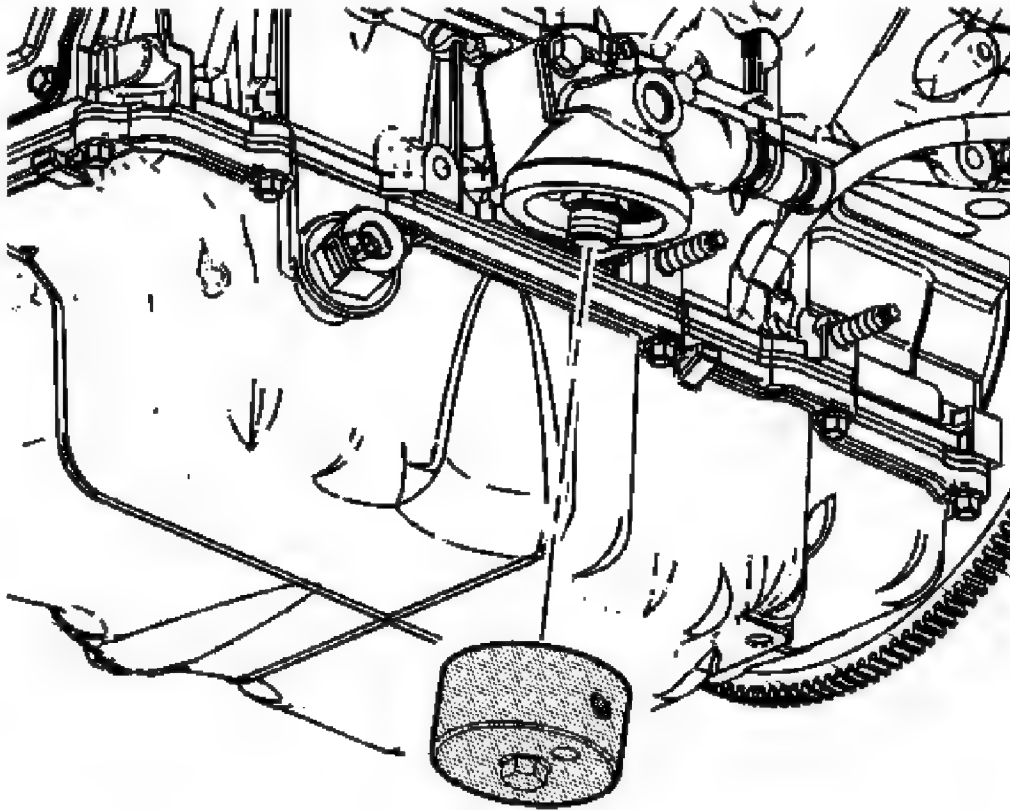


Fig. 205: View Of J 42907 Oil Pressure Tester
Courtesy of GENERAL MOTORS CORP.

10. Remove the **J 42907** from the oil filter adapter. See **Special Tools** .
11. Ensure the NEW oil filter is filled with clean fresh engine oil.

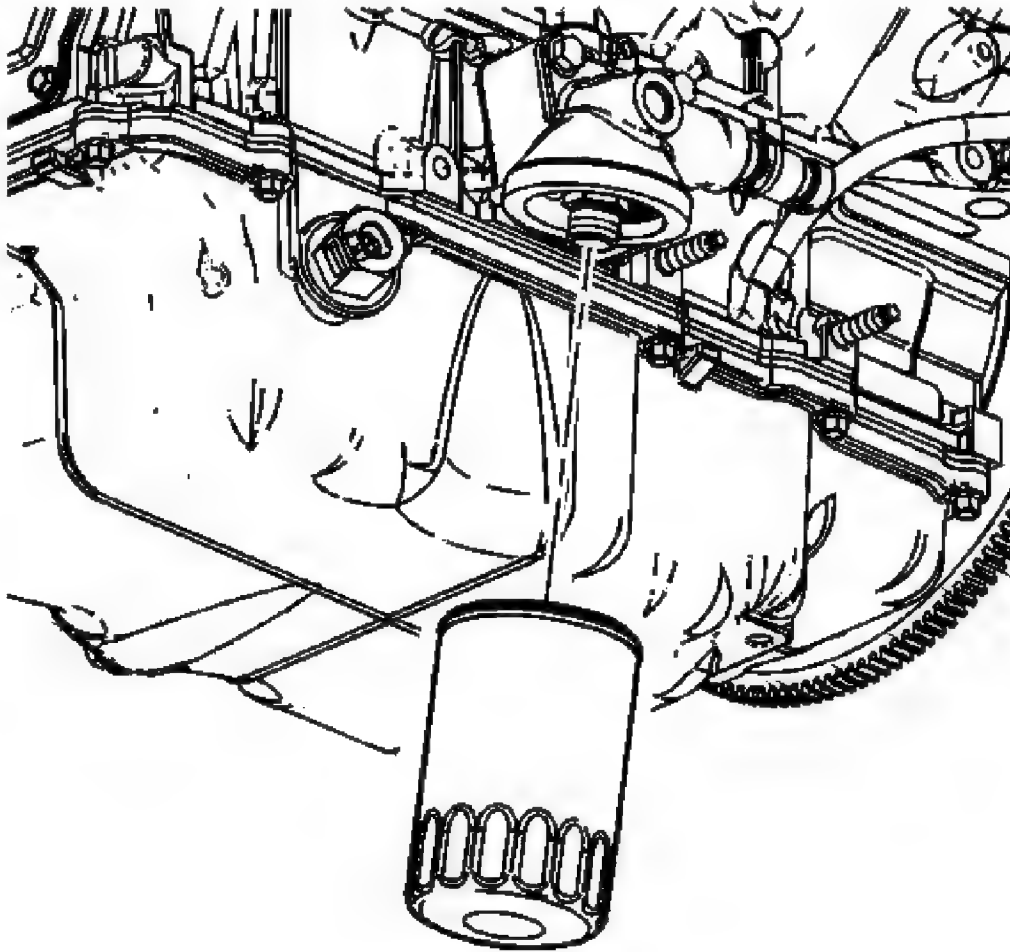


Fig. 206: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

12. Install the NEW oil filter.

Tighten: Tighten the oil filter to 32 N.m (24 lb ft).

2006 Buick Lucerne CXS

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